# City of Beaverton

## Natural Hazards Mitigation Plan

### Report for:

**City of Beaverton**

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97005

### Prepared by:

**Oregon Natural Hazards Workgroup**

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## Special Thanks &
# Acknowledgements

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### Geographic Information Systems (GIS) Maps:

*City of Beaverton GIS Services developed all of the maps included in this plan. The contributions from this department were essential in illustrating the extent and potential losses associated with the natural hazards affecting the County.*


Traci Rigby, GIS Supervisor, City of Beaverton GIS
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*The information on the maps in this plan was derived from the City of Beaverton's GIS using existing city, county, regional and state geographical databases. Care was taken in the creation of these maps, but are provided "as is" using the "best available" data. The City cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties that accompany these products (the maps). Although information from Land Surveys may have been used in the creation of these products, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.*

# City of Beaverton
## Natural Hazards Mitigation Plan
# Table of Contents

# Executive Summary

The City of Beaverton (the City) developed this Natural Hazard Mitigation Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

Natural hazard mitigation is defined as a method permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Natural hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.[1]

## Why Develop this Mitigation Plan?

This natural hazard mitigation plan is intended to assist the City of Beaverton in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City. The City received one third of the funds to develop the plan from the Flood Mitigation Assistance (FMA) Program, a Federal Emergency Management Agency (FEMA) grant program. The remainder of the plan was funded through the City of Beaverton General Fund.

## How is the Plan Organized?

The Mitigation Plan contains background on the purpose of the plan, the methodology used to develop the plan, a profile of Beaverton, chapters on six natural hazards that have the potential to impact the City, and several appendices. All of the sections are described in detail in Chapter 1, Introduction.

The Plan also includes resources and information to assist city residents, public and private sector organizations, and others to participate in activities which mitigate against the effects of natural hazards. The mitigation plan provides recommendations for activities that will assist the City in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for the hazards of flood, severe weather, landslides, wildfire, earthquake, and volcano-related events. This section contains a five-year plan matrix that incorporates the identified action items.

## Who Participated in Developing the Plan?

The City of Beaverton Natural Hazards Mitigation Plan is the result of a collaborative effort between Beaverton citizens, public agencies, non-profit organizations, the private sector, and state and regional organizations. Public participation played a key role in the development of goals and action items. The research team conducted interviews with stakeholders throughout the City, held multiple focus groups, and researched and reviewed information on each of the six hazards most common to Beaverton. A project steering committee guided the process of developing the plan. The steering committee was comprised of representatives from the following organizations:

- City of Beaverton Emergency Management Program
- City of Beaverton Community Development Department
- City of Beaverton Engineering Department
- City of Beaverton Buildings Division
- City of Beaverton GIS Services
- City of Beaverton Operations and Maintenance Department
- City of Beaverton Mayor's Office
- Office of Consolidated Emergency Management (OCEM)
- Portland General Electric (PGE)
- American Red Cross
- Beaverton Chamber of Commerce
- Oregon Emergency Management

## What is the Plan's Mission?

The mission of the Beaverton Natural Hazards Mitigation Plan is to assist in reducing risk, preventing loss, and protecting life, property, and the environment from future natural hazard events. The plan fosters coordinated partnerships and the development of multi-objective strategies for reducing the risks posed by natural hazards.

## What are the Plan Goals?

The plan goals describe the overall direction that City of Beaverton agencies, organizations, and citizens can take to work toward mitigating risk from natural hazards. The Beaverton plan goals were adapted from goals originally developed for the Washington County Natural Hazard Mitigation Plan and incorporated the input of the City's project steering committee. This helped ensure an element of continuity between the two plans. The overarching plan vision is to create a disaster resistant and resilient community[2] through four

Goals– each with its own list of objectives. The Goals and Objectives are as follows:

## Goal 1: Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

1. Reduce insurance losses and repetitive claims for chronic hazard events while promoting insurance coverage for catastrophic hazards;
2. Evaluate applicable city guidelines, codes, and permitting processes regarding how the City address natural hazard mitigation;
3. Link watershed planning, natural resource management, and land use planning with natural hazard mitigation activities to protect vital habitat and water quality;
4. Preserve and rehabilitate natural systems to serve natural hazard mitigation functions; and
5. Continuously develop and update natural hazard related datasets.

## Goal 2: Improve Partnerships for Communication and Coordination

1. Develop and implement natural hazard education and outreach programs to increase awareness among citizens; local, city, and regional agencies; non-profit organizations; and businesses; and
2. Strengthen communication, coordination, and collaboration among public agencies, citizens, non-profit organizations, and businesses working in natural hazard risk reduction.

## Goal 3: Enhance Emergency Services

1. Strengthen emergency operations by increasing communication, collaboration and coordination among public agencies, non-profit organization, and businesses; and
2. Coordinate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

## Goal 4: Ensure Implementation of Mitigation Activities

1. Develop partnerships and promote leadership among within local and regional public agencies, citizens, non-profit organizations, and businesses to implement natural hazard mitigation activities;
2. Ensure consistency between city, county, regional, and state mitigation activities; and
3. Consistently, seek diverse funding and resource partnerships for future mitigation efforts.

## How are the Action Items Organized?

The action items are organized within the following matrix, which lists all of the multi-hazard and hazard-specific action items included in the mitigation plan. Data collection and research and the public participation process resulted in the development of these action items. The matrix includes the following information for each action item:

- **Coordinating Organization.** The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. The coordinating organization for all action items listed in this plan shall be the City of Beaverton.
- **Internal Partners:** Internal partner organizations are departments within the City that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.
- **External Partners:** External partner organizations can assist the City in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

  The internal and external partner organizations listed in the mitigation plan are potential partners recommended by the project steering committee, but who were not necessarily contacted during the development of the plan. Partner organizations should be contacted by the coordinating organization to establish commitment of time and or resources to action items.
- **Timeline**. Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term action items (ST)* are activities which city agencies are capable of implementing with existing resources and authorities within one to two years. *Long-term action items (LT)* may require new or additional resources or authorities, and may take between one and five years to implement.
- **Ideas for Implementation**. Each action item includes ideas for implementation and potential resources, which may include grant programs or human resources. The matrix includes the page number within the mitigation plan where this information can be found.
- **Plan Goals Addressed.** The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals following implementation.

## How Will the Plan be Implemented?

The plan maintenance section of this document details the formal process that will ensure that the Beaverton Natural Hazards Mitigation

Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a plan revision every five years. This section describes how the City will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how the City of Beaverton intends to incorporate the mitigation strategies outlined in this Plan into existing mechanisms such as the Comprehensive Plan, Capital Improvement Plans, Transportation Plans, Development Code, and Engineering Design Manual.

## Plan Adoption

Government at all levels has the responsibility to plan for, respond to, recover from, and mitigate against emergencies resulting from hazards which are known to threaten the jurisdiction. In view of this fact, the City of Beaverton has established an Emergency Management Program to provide overall planning and coordination for emergencies.

This Natural Hazards Mitigation Plan (NHMP) covers those activities associated with the Mitigation phase of Emergency Management relative to natural hazards. The mitigation plan provides recommendations for activities that will assist the City in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for flood, severe weather, landslide, wildfire, earthquake, and volcanic eruption hazards.

The Beaverton City Council will be responsible for adopting the City of Beaverton Natural Hazards Mitigation Plan and providing the support necessary to ensure plan implementation. Once the plan has been adopted, the City Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer at Oregon Emergency Management. Oregon Emergency Management will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201.6 published in February 2002. Upon acceptance by FEMA, the City of Beaverton will gain eligibility for Hazard Mitigation Grant Program and Pre-Disaster Mitigation program funds.

The accomplishment of the Natural Hazards Mitigation Plan goals and objectives depends on the maintenance of competent Steering Committee and adequate support from the city departments reflected in the plan in incorporating the outlined action items into existing city plans and procedures. It is hereby directed that the appropriate city departments and programs as outlined in the plan accomplish review and maintenance of this plan and implementation of the recommended activities. Thorough familiarity with this Plan will result in the efficient and effective implementation of appropriate mitigation activities and a reduction in the risk and the potential for loss from future natural hazard events.

## Coordinating Body

The City of Beaverton Hazard Mitigation Steering Committee will be responsible for coordinating the implementation of plan action items and undertaking the formal review process. The Mayor's Office will ensure that the appropriate department representatives are assigned, including, but not limited to, the current Hazard Mitigation Steering Committee members.

## Convener

Although the City Council will provide ownership of the City of Beaverton Natural Hazard Mitigation Plan, the City's Emergency Manager will take responsibility for plan implementation.

## Implementation through Existing Programs

The City of Beaverton addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvement plans, and City building codes. The natural hazard mitigation plan provides a series of recommendations – many of which are closely related to the goals and objectives of existing planning programs. To the extent possible the City of Beaverton will incorporate the recommended mitigation action items into existing programs and procedures.

## Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's (FEMA) methods of identifying the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

## Formal Review Process

The City of Beaverton has developed a method to ensure that a regular review and update of the Hazard Mitigation Plan occurs. All Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan and the Emergency Manager is responsible for contacting the Committee members and organizing the annual plan review meeting.

## Continued Public Involvement

The City of Beaverton is dedicated to involving the public directly in the continual reshaping and updating of the Hazard Mitigation Plan. The Hazard Mitigation Steering Committee members are responsible for the annual review and update of the plan. Although they represent the public to some extent, the public will have the opportunity to provide feedback about the Plan.

Copies of the Plan will be catalogued and kept at the City of Beaverton public library and may be posted on the City website. A public meeting will also be held after each annual evaluation or when deemed necessary by the Hazard Mitigation Steering Committee.

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## Executive Summary Endnotes

[1] Massachusetts Department of Environmental Management. 1999. "Hazard Mitigation: Managing Risks, Lowering Costs. http://www.state.ma.us/dem/programs/mitigate/whatis.htm Accessed 8/2/02

[2] Communities are resistant when the impacts of disasters are lessened and resilient when they are able to "bounce" back from a disaster. Because disasters can impact the social, economic, and environmental fabric of a community, it is important to be resistant and resilient to disasters. Social consequences of disasters include the loss of security, increased stress and anxiety, diminished distrust in government, and the disruption of familiar environments and daily routines. Economic objectives include retaining existing businesses, promoting continued or new economic development, and ensuring that businesses are built safer, smarter and stronger. An added key environmental component of disaster resistance and resilience is preserving the integrity of biological and physical systems which includes limiting degradation of the environment and preserving natural systems – such as wetlands, floodplains, dunes, and active fault/landslide zones. Definition provided by FEMA's Planning for a Sustainable Future. The Link Between Hazard Mitigation and Livability.

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| ***Beaverton Natural Hazard Mitigation Plan Action Items - Prioritized by Action Item Priority Score*** | | | | | | | | | |
| Short-Term Multi-Hazard #1 | Establish a Beaverton Natural Hazards Mitigation Plan Steering Committee to facilitate implementation, monitoring, and evaluation of citywide mitigation activities. | Emergency Management Program, Mayor's Office | X | 3 Months | pg. 6-4 | | ✓ | | ✓ |
| Short-Term Multi-Hazard #3 | Develop public and private partnerships to foster natural hazard program coordination and collaboration within the Beaverton Urban Service Boundary. | Emergency Management Program, Community Development Department, Economic Development Program, Neighborhood Program | 18 | Ongoing | pg. 6-5 | ✓ | ✓ | | ✓ |
| Long-Term Multi-Hazard #2 | Implement appropriate mitigation measures at development sites prior to approval. | ISD/GIS, Community Development Department, Emergency Management Program, Neighborhood Program | 18 | Ongoing | pg. 6-8 | ✓ | ✓ | | ✓ |
| Long-Term Multi-Hazard #3 | Create and maintain a system to support populations with special needs within Beaverton's city limits. | ISD/GIS, Community Development Department, Emergency Management Program, Neighborhood Program | 18 | Ongoing | pg. 6-9 | ✓ | ✓ | | ✓ |
| Long-Term Multi-Hazard #4 | Improve public awareness and provide potential steps to reduce natural hazard risk. | Neighborhood Program, Emergency Management Program | 18 | Ongoing | pg. 6-8 | ✓ | ✓ | | ✓ |
| Short-Term Multi-Hazard #2 | Identify and pursue funding opportunities to develop and implement local mitigation activities. | Emergency Management Program, Economic Development Program | 17 | Ongoing | pg. 6-5 | ✓ | ✓ | | |
| Short-Term Multi-Hazard #5 | Strengthen emergency services by updating the City Emergency Operations Plan, linking emergency services with natural hazard mitigation programs, and enhancing public education | Emergency Management Program, Disaster Planning Team, ISD/GIS | 17 | 1-2 Years | pg. 6-7 | ✓ | | ✓ | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority ------------------><br>Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long -Term Multi-Hazard #1 | Increase technical knowledge of natural hazards and mitigation strategies in Beaverton and implement policies and program based on that knowledge. | ISD/GIS, Operations and Maintenance Department, Emergency Management Program, Community Development Department | 17 | Ongoing | pg. 6-7 | ✓ | ✓ | | |
| Short-Term Multi-Hazard #4 | Encourage households and businesses in Beaverton to consider natural hazard related insurance. | Emergency Management Program, Economic Development Program | 15 | 1-2 Years | pg. 6-6 | ✓ | | | ✓ |
| Long-Term Flood #6 | Create a regional partnership to reduce flood loss across the region. | Community Development Department, Engineering Department, ISD/GIS | 15 | 1-5 Years | pg. 7-34 | ✓ | | | ✓ |
| Short-Term Earthquake #1 | Identify funding sources for implementing earthquake mitigation in Beaverton | Engineering Department, Economic Development Program, Community Development Department, Emergency Management Program | 13 | 1-2 Years | pg. 11-20 | ✓ | ✓ | | ✓ |
| Long-Term Earthquake #1 | Establish a program aimed at helping private property owners and businesses perform structural retrofitting. | Economic Development Program, Neighborhood Program | 13 | Ongoing | pg. 11-22 | ✓ | ✓ | | ✓ |
| Short-Term Earthquake #2 | Reduce non-structural hazards in homes, schools, businesses, and government offices. | Economic Development Program | 12 | 1-2 Years | pg. 11-20 | ✓ | ✓ | | |
| Short-Term Severe Weather#1 | Maintain public awareness of the hazard and the benefits of mitigation through education aimed at households and businesses and increase targeting of special needs populations. | Economic Development Program, Community Development Department | 11 | 1-2 Years | pg. 8-17 | ✓ | | ✓ | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed (Highest Priority ------------------>): Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long-Term Landslide #3 | Protect existing development in landslide-prone areas. | Community Development Department | 11 | Ongoing | pg. 9-20 | ✓ | ✓ | | ✓ |
| Long-Term Landslide #5 | Maintain public and private drainage systems. | Operations and Maintenance Department | 11 | Ongoing | pg. 9-21 | ✓ | ✓ | | ✓ |
| Short-Term Flood #1 | Evaluate the requirements for Beaverton to become a participant in the NFIP's Community Rating System (CRS). | Emergency Management Program, Operations and Maintenance Department | 10 | 1 Year | pg. 7-28 | ✓ | | | |
| Short-Term Flood #2 | Analyze each repetitive loss property to identify viable mitigation options. | Emergency Management Program, Community Development Department, Engineering, ISD/GIS | 10 | Ongoing | pg. 7-29 | ✓ | | | |
| Long-Term Flood #1 | Develop acquisition and management strategies to preserve open space in the floodplain. | Community Development Department, Emergency Management Program | 10 | Ongoing | pg. 7-30 | ✓ | | | |
| Long-Term Flood #3 | Enhance data and mapping for floodplain information within the City. | Engineering Department, Operations and Maintenance Department, ISD/GIS | 10 | 1-5 Years | pg. 7-29 | ✓ | | | |
| Long-Term Flood #4 | Use storm water and urban design best management practices (BMPs). | Community Development Department, Engineering Department | 10 | 1-5 Years | pg. 7-32 | ✓ | | | |
| Long-Term Flood #5 | Update City code to improve risk reduction and prevention of natural hazard impacts. | Community Development Department | 10 | 1-2 Years | pg. 7-33 | ✓ | | | |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority ------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| Long-Term Earthquake #5 | Assure that all Beaverton residents, regardless of income, disability, or ethnic group, receive information about earthquakes and have the opportunity to mitigate earthquake hazards in their home. | Economic Development Program, Neighborhood Program | 10 | Ongoing | pg. 11-24 | ✓ | | | ✓ |
| Long-Term Landslide #4 | Implement construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development. | Community Development Department, Engineering Department | 10 | 1-3 Years | pg. 9-21 | ✓ | ✓ | | |
| Short-Term Earthquake #4 | Improve technical data and analysis of earthquake hazards. | Community Development Department, ISD/GIS | 9 | Ongoing | pg. 11-21 | ✓ | | | |
| Long-Term Earthquake #2 | Encourage purchase of earthquake hazard insurance by forming partnerships with the insurance and real estate industries. | Neighborhood Program - Mayor's Office | 9 | Ongoing | pg. 11-22 | ✓ | | | |
| Long-Term Earthquake #3 | Develop public/private partnerships to pursue efficient methods to retrofit structures. | Economic Development Program, Emergency Management Program, Community Development Department | 9 | Ongoing | pg. 11-23 | ✓ | | | |
| Long-Term Earthquake #4 | Improve local capabilities to perform earthquake building safety evaluations. | Emergency Management Program, ISD/GIS | 9 | Ongoing | pg. 11-23 | ✓ | | | |
| Long -Term Severe Weather#3 | Develop and maintain comprehensive impact database and when possible, map historical severe weather events in Beaverton. | Community Development Department, ISD/GIS. | 9 | Ongoing | pg. 8-19 | ✓ | | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed Highest Priority -------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| Short-Term Flood #3 | Develop mitigation and preparedness measures for critical public infrastructure and facilities located in flood hazard areas. | ISD/GIS, Emergency Management Program | 8 | 1-3 Years | pg. 7-29 | | | ✓ | |
| Short-Term Severe Weather#2 | Maintain tree trimming for above ground power lines. | Community Development Department, Emergency Management Program, Operations and Maintenance Department/Urban Forestry | 8 | Ongoing | pg. 8-18 | ✓ | | | |
| Long -Term Severe Weather#1 | Identify trees that are potentially susceptible to windthrow. | Operations and Maintenance Department/Urban Forestry, ISD/GIS | 8 | Ongoing | pg. 8-18 | ✓ | | | |
| Long -Term Severe Weather#2 | Develop and implement programs to keep trees from threatening lives, property, and public infrastructure from severe weather events. | ISD/GIS, Operations and Maintenance Department/Urban Forestry, Community Development Department | 8 | Ongoing | pg. 8-19 | ✓ | | | |
| Long -Term Severe Weather#4 | Support underground utility construction through public incentives and partnerships. | Community Development Department, ISD/GIS. | 8 | Ongoing | pg. 8-20 | ✓ | | | |
| Long -Term Severe Weather#5 | | Operations and Maintenance Department/Urban Forestry, ISD/GIS | 8 | Ongoing | pg. 8-20 | ✓ | | | |
| Long-Term Landslide #1 | Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in those areas. | Community Development Department | 8 | Ongoing | pg. 9-19 | ✓ | | | ✓ |
| Long-Term Landslide #2 | Limit activities in identified landslide hazard areas through regulation and public outreach. | Community Development Department | 8 | Ongoing | pg. 9-19 | ✓ | | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority ------------------->  Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long-Term Wildfire #3 | Increase communication, coordination, and collaboration between wildland/urban interface property owners, city and county planners, and fire prevention crews and officials to address inherent risks in wildland/urban interface areas, available prevention/protection measures, and federal mitigation assistance programs. | Emergency Management Program, Community Development Department | 8 | 1-5 Years | pg. 10-20 | ✓ | | ✓ | ✓ |
| Long-Term Flood #2 | Provide flood event education and outreach to households and businesses. | ISD/GIS, Emergency Management Program | 7 | 18 Months | pg. 7-31 | | | | ✓ |
| Short-Term Earthquake #3 | Pursue structural mitigation of critical facilities, infrastructure, public buildings, and schools for the earthquake threat. | Economic Development Program, Engineering Department, Operations and Maintenance Department | 7 | Ongoing | pg. 11-20 | | | ✓ | |
| Short-Term Volcano #2 | Collaborate with USGS-CVO and related agencies to increase awareness of volcanic response efforts through ash fall related messages. | Emergency Management Program | 7 | Ongoing | pg. 12-14 | ✓ | | | ✓ |
| Long-Term Volcano #1 | Map and model ash fall. | ISD/GIS | 6 | 1-5 Years | pg. 12-15 | ✓ | | | |
| Long-Term Volcano #2 | Establish a plan for ash removal following a volcanic event. | Emergency Management Program, Operations and Maintenance Department | 6 | 1-5 Years | pg. 12-15 | ✓ | | | |
| Long-Term Wildfire #1 | Encourage the creation and adoption of wildland interface maps to build development requirements that assist wildfire mitigation. | ISD/GIS, Emergency Management Program, Community Development Department | 6 | 1-5 Years | pg. 10-19 | ✓ | | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority ------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| Long-Term Wildfire #2 | Develop and implement, or enhance existing outreach and education programs aimed at mitigating wildfire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners, and businesses to natural hazards. | Emergency Management Program Program, Neighborhood Program, Community Development Department | 6 | Ongoing | pg. 10-20 | ✓ | | | ✓ |
| Short-Term Volcano #1 | Identify critical facilities and industries that may be affected by ash fall and collaborate with them on ash fall emergency response. | Emergency Management Program, Operations and Maintenance Department | 5 | 1-2 Years | pg. 12 -14 | | | ✓ | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed Highest Priority ------------------> Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| ***Beaverton Natural Hazard Mitigation Plan Action Items - Organized by Hazard*** | | | | | | | | | |
| ***Multi-Hazard Mitigation Action Items*** | | | | | | | | | |
| Short-Term Multi-Hazard #1 | Establish a Beaverton Natural Hazards Mitigation Plan Steering Committee to facilitate implementation, monitoring, and evaluation of citywide mitigation activities. | Emergency Management Program, Mayor's Office | 14 | 3 Months | pg. 6-4 | | ✓ | | ✓ |
| Short-Term Multi-Hazard #2 | Identify and pursue funding opportunities to develop and implement local mitigation activities. | Emergency Management Program, Economic Development Program | 17 | Ongoing | pg. 6-5 | ✓ | ✓ | | |
| Short-Term Multi-Hazard #3 | Develop public and private partnerships to foster natural hazard program coordination and collaboration within the Beaverton Urban Service Boundary. | Emergency Management Program, Community Development Department, Economic Development Program, Neighborhood Program | 18 | Ongoing | pg. 6-5 | ✓ | ✓ | | ✓ |
| Short-Term Multi-Hazard #4 | Encourage households and businesses in Beaverton to consider natural hazard related insurance. | Emergency Management Program, Economic Development Program | 15 | 1-2 Years | pg. 6-6 | ✓ | | | ✓ |
| Short-Term Multi-Hazard #5 | Strengthen emergency services by updating the City Emergency Operations Plan, linking emergency services with natural hazard mitigation programs, and enhancing public education | Emergency Management Program, Disaster Planning Team, ISD/GIS | 17 | 1-2 Years | pg. 6-7 | ✓ | | ✓ | ✓ |
| Long -Term Multi-Hazard #1 | Increase technical knowledge of natural hazards and mitigation strategies in Beaverton and implement policies and program based on that knowledge. | ISD/GIS, Operations and Maintenance Department, Emergency Management Program, Community Development Department | 17 | Ongoing | pg. 6-7 | ✓ | ✓ | | |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------><br>Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long-Term Multi-Hazard #2 | Implement appropriate mitigation measures at development sites prior to approval. | ISD/GIS, Community Development Department, Emergency Management Program, Neighborhood Program | 18 | Ongoing | pg. 6-8 | ✓ | ✓ | | ✓ |
| Long-Term Multi-Hazard #3 | Create and maintain a system to support populations with special needs within Beaverton's city limits. | ISD/GIS, Community Development Department, Emergency Management Program, Neighborhood Program | 18 | Ongoing | pg. 6-8 | ✓ | ✓ | | ✓ |
| Long-Term Multi-Hazard #4 | Improve public awareness and provide potential steps to reduce natural hazard risk. | Neighborhood Program, Emergency Management Program | 18 | Ongoing | pg. 6-9 | ✓ | ✓ | | ✓ |
| ***Flood Mitigation Action Items***<br>***Beaverton Business Continuity Plan - Risk Assessment Score: 267**** | | | | | | | | | |
| Short-Term Flood #1 | Evaluate the requirements for Beaverton to become a participant in the NFIP's Community Rating System (CRS). | Emergency Management Program, Operations and Maintenance Department | 10 | 1 Year | pg. 7-28 | ✓ | | | |
| Short-Term Flood #2 | Analyze each repetitive loss property to identify viable mitigation options. | Emergency Management Program, Community Development Department, Engineering, ISD/GIS | 10 | Ongoing | pg. 7-29 | ✓ | | | |
| Short-Term Flood #3 | Develop mitigation and preparedness measures for critical public infrastructure and facilities located in flood hazard areas. | ISD/GIS, Emergency Management Program | 8 | 1-3 Years | pg. 7-29 | | | ✓ | |
| Long-Term Flood #1 | Develop acquisition and management strategies to preserve open space in the floodplain. | Community Development Department, Emergency Management Program | 10 | Ongoing | pg. 7-30 | ✓ | | | |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| Long-Term Flood #2 | Provide flood event education and outreach to households and businesses. | ISD/GIS, Emergency Management Program | 7 | 18 Months | pg. 7-31 | | | | ✓ |
| Long-Term Flood #3 | Enhance data and mapping for floodplain information within the City. | Engineering Department, Operations and Maintenance Department, ISD/GIS | 10 | 1-5 Years | pg. 7-32 | ✓ | | | |
| Long-Term Flood #4 | Use storm water and urban design best management practices (BMPs). | Community Development Department, Engineering Department | 10 | 1-5 Years | pg. 7-32 | ✓ | | | |
| Long-Term Flood #5 | Update City code to improve risk reduction and prevention of natural hazard impacts. | Community Development Department | 10 | 1-2 Years | pg. 7-33 | ✓ | | | |
| Long-Term Flood #6 | Create a regional partnership to reduce flood loss across the region. | Community Development Department, Engineering Department, ISD/GIS | 15 | 1-5 Years | pg. 7-34 | ✓ | | | ✓ |
| ***Earthquake Mitigation Action Items***<br>***Beaverton Business Continuity Plan - Risk Assessment Score: 240*** | | | | | | | | | |
| Short-Term Earthquake #1 | Identify funding sources for implementing earthquake mitigation in Beaverton | Engineering Department, Economic Development Program, Community Development Department, Emergency Management Program | 13 | 1-2 Years | pg. 11-20 | ✓ | ✓ | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------><br>Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Short-Term Earthquake #2 | Reduce non-structural hazards in homes, schools, businesses, and government offices. | Economic Development Program | 12 | 1-2 Years | pg. 11-20 | ✓ | ✓ | | |
| Short-Term Earthquake #3 | Pursue structural mitigation of critical facilities, infrastructure, public buildings, and schools for the earthquake threat. | Economic Development Program, Engineering Department, Operations and Maintenance Department | 7 | Ongoing | pg. 11-21 | | | ✓ | |
| Short-Term Earthquake #4 | Improve technical data and analysis of earthquake hazards. | Community Development Department, ISD/GIS | 9 | Ongoing | pg. 11-21 | ✓ | | | |
| Long-Term Earthquake #1 | Establish a program aimed at helping private property owners and businesses perform structural retrofitting. | Economic Development Program, Neighborhood Program | 13 | Ongoing | pg. 11-22 | ✓ | ✓ | | ✓ |
| Long-Term Earthquake #2 | Encourage purchase of earthquake hazard insurance by forming partnerships with the insurance and real estate industries. | Neighborhood Program - Mayor's Office | 9 | Ongoing | pg. 11-22 | ✓ | | | |
| Long-Term Earthquake #3 | Develop public/private partnerships to pursue efficient methods to retrofit structures. | Economic Development Program, Emergency Management Program, Community Development Department | 9 | Ongoing | pg. 11-23 | ✓ | | | |
| Long-Term Earthquake #4 | Improve local capabilities to perform earthquake building safety evaluations. | Emergency Management Program, ISD/GIS | 9 | Ongoing | pg. 11-23 | ✓ | | | |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------><br>Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long-Term Earthquake #5 | Assure that all Beaverton residents, regardless of income, disability, or ethnic group, receive information about earthquakes and have the opportunity to mitigate earthquake hazards in their home. | Economic Development Program, Neighborhood Program | 10 | Ongoing | pg. 11-24 | ✓ | | | ✓ |
| ***Severe Weather Mitigation Action Items***<br>***Beaverton Business Continuity Plan - Risk Assessment Score: 100*** | | | | | | | | | |
| Short-Term Severe Weather#1 | Maintain public awareness of the hazard and the benefits of mitigation through education aimed at households and businesses and increase targeting of special needs populations. | Economic Development Program, Community Development Department | 11 | 1-2 Years | pg. 8-17 | ✓ | | ✓ | ✓ |
| Short-Term Severe Weather#2 | Maintain tree trimming for above ground power lines. | Community Development Department, Emergency Management Program, Operations and Maintenance Department/Urban Forestry | 8 | Ongoing | pg. 8-18 | ✓ | | | |
| Long -Term Severe Weather#1 | Identify trees that are potentially susceptible to windthrow. | Operations and Maintenance Department/Urban Forestry, ISD/GIS | 8 | Ongoing | pg. 8-18 | ✓ | | | |
| Long -Term Severe Weather#2 | Develop and implement programs to keep trees from threatening lives, property, and public infrastructure from severe weather events. | ISD/GIS, Operations and Maintenance Department/Urban Forestry, Community Development Department | 8 | Ongoing | pg. 8-19 | ✓ | | | |
| Long -Term Severe Weather#3 | Develop and maintain comprehensive impact database and when possible, map historical severe weather events in Beaverton. | Community Development Department, ISD/GIS. | 9 | Ongoing | pg. 8-19 | ✓ | | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed (Highest Priority ------------------>) Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long -Term Severe Weather#4 | Support underground utility construction through public incentives and partnerships. | Community Development Department, ISD/GIS. | 8 | Ongoing | pg. 8-20 | ✓ | | | |
| Long -Term Severe Weather#5 | Develop strategies for better debris removal after a windstorm. | Operations and Maintenance Department/Urban Forestry, ISD/GIS | 8 | Ongoing | pg. 8-20 | ✓ | | | |
| ***Landslide Mitigation Action Items*** ***Beaverton Business Continuity Plan - Risk Assessment Score: 24**** | | | | | | | | | |
| Long-Term Landslide #1 | Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in those areas. | Community Development Department | 8 | Ongoing | pg. 9-19 | ✓ | | | ✓ |
| Long-Term Landslide #2 | Limit activities in identified landslide hazard areas through regulation and public outreach. | Community Development Department | 8 | Ongoing | pg. 9-19 | ✓ | | | ✓ |
| Long-Term Landslide #3 | Protect existing development in landslide-prone areas. | Community Development Department | 11 | Ongoing | pg. 9-20 | ✓ | ✓ | | ✓ |
| Long-Term Landslide #4 | Implement construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development. | Community Development Department, Engineering Department | 10 | 1-3 Years | pg. 9-21 | ✓ | ✓ | | |
| Long-Term Landslide #5 | Maintain public and private drainage systems. | Operations and Maintenance Department | 11 | Ongoing | pg. 9-21 | ✓ | ✓ | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed Highest Priority -------------------> | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
| ***Volcanic Eruption Mitigation Action Items*** ***Beaverton Business Continuity Plan - Risk Assessment Score: 10*** | | | | | | | | | |
| Short-Term Volcano #1 | Identify critical facilities and industries that may be affected by ash fall and collaborate with them on ash fall emergency response. | Emergency Management Program, Operations and Maintenance Department | 5 | 1-2 Years | pg. 12-14 | | | ✓ | ✓ |
| Short-Term Volcano #2 | Collaborate with USGS-CVO and related agencies to increase awareness of volcanic response efforts through ash fall related messages. | Emergency Management Program | 7 | Ongoing | pg. 12-14 | ✓ | | | ✓ |
| Long-Term Volcano #1 | Map and model ash fall. | ISD/GIS | 6 | 1-5 Years | pg. 12-15 | ✓ | | | |
| Long-Term Volcano #2 | Establish a plan for ash removal following a volcanic event. | Emergency Management Program, Operations and Maintenance Department | 6 | 1-5 Years | pg. 12-15 | ✓ | | | |
| ***Wildfire Mitigation Action Items*** ***Beaverton Business Continuity Plan - Risk Assessment Score: 8**** | | | | | | | | | |
| Long-Term Wildfire #1 | Encourage the creation and adoption of wildland interface maps to build development requirements that assist wildfire mitigation. | ISD/GIS, Emergency Management Program, Community Development Department | 6 | 1-5 Years | pg. 10-19 | ✓ | | | ✓ |

| Natural Hazard | Action Item | Internal Partners | Action Item Priority Score | Timeline | Ideas for Implementation | Plan Goals Addressed<br>Highest Priority -------------------><br>Protect human life, commerce, property, and natural systems | Ensure Implementation of Mitigation Activities | Enhance Emergency Services | Improve Partnerships for Communication and Coordination |
|---|---|---|---|---|---|---|---|---|---|
| Long-Term Wildfire #2 | Develop and implement, or enhance existing outreach and education programs aimed at mitigating wildfire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners, and businesses to natural hazards. | Emergency Management Program Program, Neighborhood Program, Community Development Department | 6 | Ongoing | pg. 10-20 | ✓ | | | ✓ |
| Long-Term Wildfire #3 | Increase communication, coordination, and collaboration between wildland/urban interface property owners, city and county planners, and fire prevention crews and officials to address inherent risks in wildland/urban interface areas, available prevention/protection measures, and federal mitigation assistance programs. | Emergency Management Program, Community Development Department | 8 | 1-5 Years | pg. 10-20 | ✓ | | ✓ | ✓ |

* Denotes Risk Assesment Score that has been adjusted for accuracy by Beaverton's Emergency Management Program - See Pg.1-12 for more information.

***EXAMPLE - LOCAL MITIGATION CAPABILITY ASSESSMENT***

| Agency Name | Related Internal Parnters | Action Item Associated With | Local Point of Contact | Level of Immediate Capability | | | Comments from Agency Regarding Capability | Status |
|---|---|---|---|---|---|---|---|---|
| | | | | High (Can Immediately Implement) | Medium | Low (Need for Great Deal of Funding, Staff, Time) | | |
| Example - City of Beaverton - Community Development Department | Engineering, Eco. Dev., Em. Mgt. | Example - Short-Term (ST) EQ #1 - Identify funding sources for implementing earthquake mitigation in Beaverton | CDD Director<br>4755 SW Griffith Dr.<br>Beaverton, OR 97005<br>(503) 526-2493<br>cddmail@ci.Beaverton.or.us | | ✓ | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

# City of Beaverton

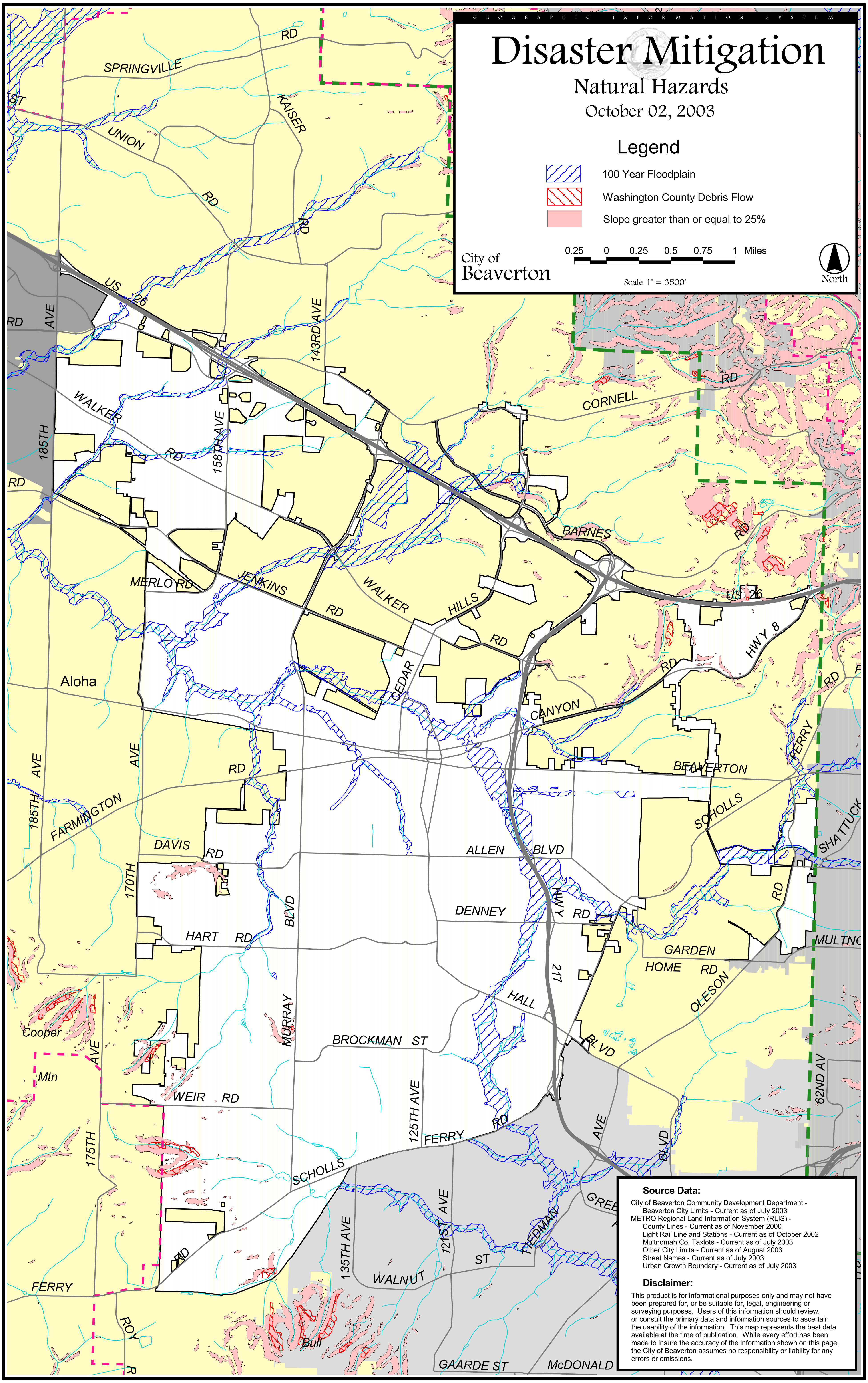
## Natural Hazard Mitigation Plan

# Map Directory

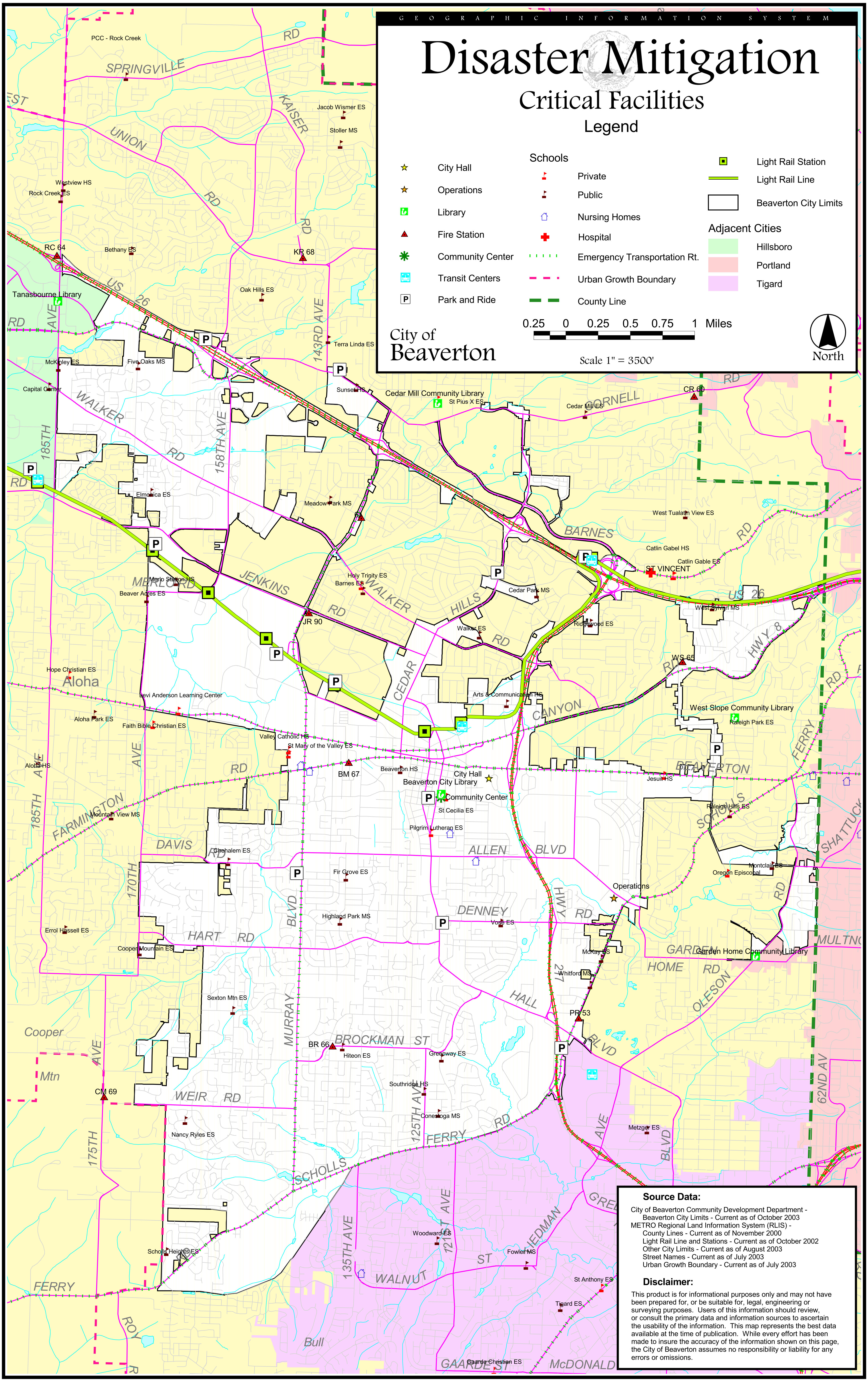
The City of Beaverton Natural Hazard Mitigation Plan utilizes a number of mapped resources which were created by the City of Beaverton Geographic Information Systems (GIS) Department. The following is a reference guide to the types of information included in the maps utilized in creating the plan.

| Map # | Map Title | Main Information Featured | Relevant Plan Chapters |
|---|---|---|---|
| **1** | Natural Hazards | 100-Year Floodplain, Debris Flows, Steep Slopes | Chapter 7: Flood<br>Chapter 9: Landslides |
| **2** | Critical Facilities | Public and Private Schools, Community Centers, Nursing Homes, Hospitals, Light Rail system | Chapter 2: Community Profile<br>Chapter 3: Risk Assessment |
| **3** | Economic Assets – Zoning | City Zoning Map | Chapter 2: Community Profile |
| **4** | Economic Assets – Employment | 1996 Employment Densities | Chapter 2: Community Profile |
| **5** | Environmental Assets – Significant Trees | Significant Trees, Groves, and Corridors | Chapter 8: Severe Weather |
| **6** | Environmental Assets – Parks and Open Spaces | Parks,Open Spaces, and Significant Wetlands | Chapter 2: Community Profile<br>Chapter 7: Flood |
| **7** | Functional Road Classification | Functional Road Classifications | Chapter 2: Community Profile |

Any questions regarding these maps should be directed to the City of Beaverton's GIS Services, 503-526-2352.




GIS/DT 10/02/2003 L_11x17_Natural Hazards s:\EmergMgt\Disaster_Mitigation\03_0265\03_0265.apr



G E O G R A P H I C   I N F O R M A T I O N   S Y S T E M
Disaster Mitigation
Critical Facilities
Legend
City Hall
Operations
Library
Fire Station
Community Center
Transit Centers
Park and Ride
Schools
Private
Public
Nursing Homes
Hospital
Emergency Transportation Rt.
Urban Growth Boundary
County Line
Light Rail Station
Light Rail Line
Beaverton City Limits
Adjacent Cities
Hillsboro
Portland
Tigard
0.25 0 0.25 0.5 0.75 1 Miles
City of Beaverton
Scale 1" = 3500'
North
Source Data:
City of Beaverton Community Development Department -
Beaverton City Limits - Current as of October 2003
METRO Regional Land Information System (RLIS) -
County Lines - Current as of November 2000
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Street Names - Current as of July 2003
Urban Growth Boundary - Current as of July 2003
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Aloha
Cooper Mtn
Bull
PCC - Rock Creek
Westview HS
Rock Creek ES
Bethany ES
Jacob Wismer ES
Stoller MS
Oak Hills ES
Terra Linda ES
Tanasbourne Library
McKinley ES
Five Oaks MS
Capital Center
Sunset HS
Cedar Mill Community Library
St Pius X ES
Cedar Mill ES
Elmonica ES
Meadow Park MS
West Tualatin View ES
Catlin Gabel HS
Catlin Gable ES
ST VINCENT
Merlo Station HS
Beaver Acres ES
Holy Trinity ES
Barnes ES
Cedar Park MS
West Sylvan MS
Ridgewood ES
Walker ES
Hope Christian ES
Levi Anderson Learning Center
Arts & Communication HS
West Slope Community Library
Raleigh Park ES
Aloha Park ES
Faith Bible Christian ES
Valley Catholic HS
St Mary of the Valley ES
Aloha HS
Beaverton HS
City Hall
Beaverton City Library
Community Center
Jesuit HS
St Cecilia ES
Mountain View MS
Pilgrim Lutheran ES
Raleigh Hills ES
Chehalem ES
Fir Grove ES
Montclair ES
Oregon Episcopal
Operations
Errol Hassell ES
Highland Park MS
Vose ES
Cooper Mountain ES
McKay ES
Garden Home Community Library
Whitford MS
Sexton Mtn ES
Hiteon ES
Greenway ES
Southridge HS
Conestoga MS
Nancy Ryles ES
Metzger ES
Woodward ES
Fowler MS
Scholls Heights ES
St Anthony ES
Tigard ES
Gaarde Christian ES
RC 64
KR 68
CR 60
JR 90
WS 65
BM 67
PR 53
BR 66
CM 69
SPRINGVILLE RD
UNION RD
KAISER RD
US 26
143RD AVE
185TH AVE
WALKER RD
158TH AVE
CORNELL RD
BARNES RD
MERLO RD
JENKINS RD
HILLS RD
CEDAR HILLS BLVD
CANYON RD
HWY 8
BEAVERTON HILLSDALE HWY
FERRY
FARMINGTON RD
170TH AVE
DAVIS RD
ALLEN BLVD
DENNEY RD
HWY 217
HART RD
MURRAY BLVD
HALL BLVD
GARDEN HOME RD
OLESON RD
MULTNOMAH
SHATTUCK RD
SCHOLLS FERRY RD
BROCKMAN ST
WEIR RD
175TH AVE
125TH AVE
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WALNUT ST
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HALL BLVD
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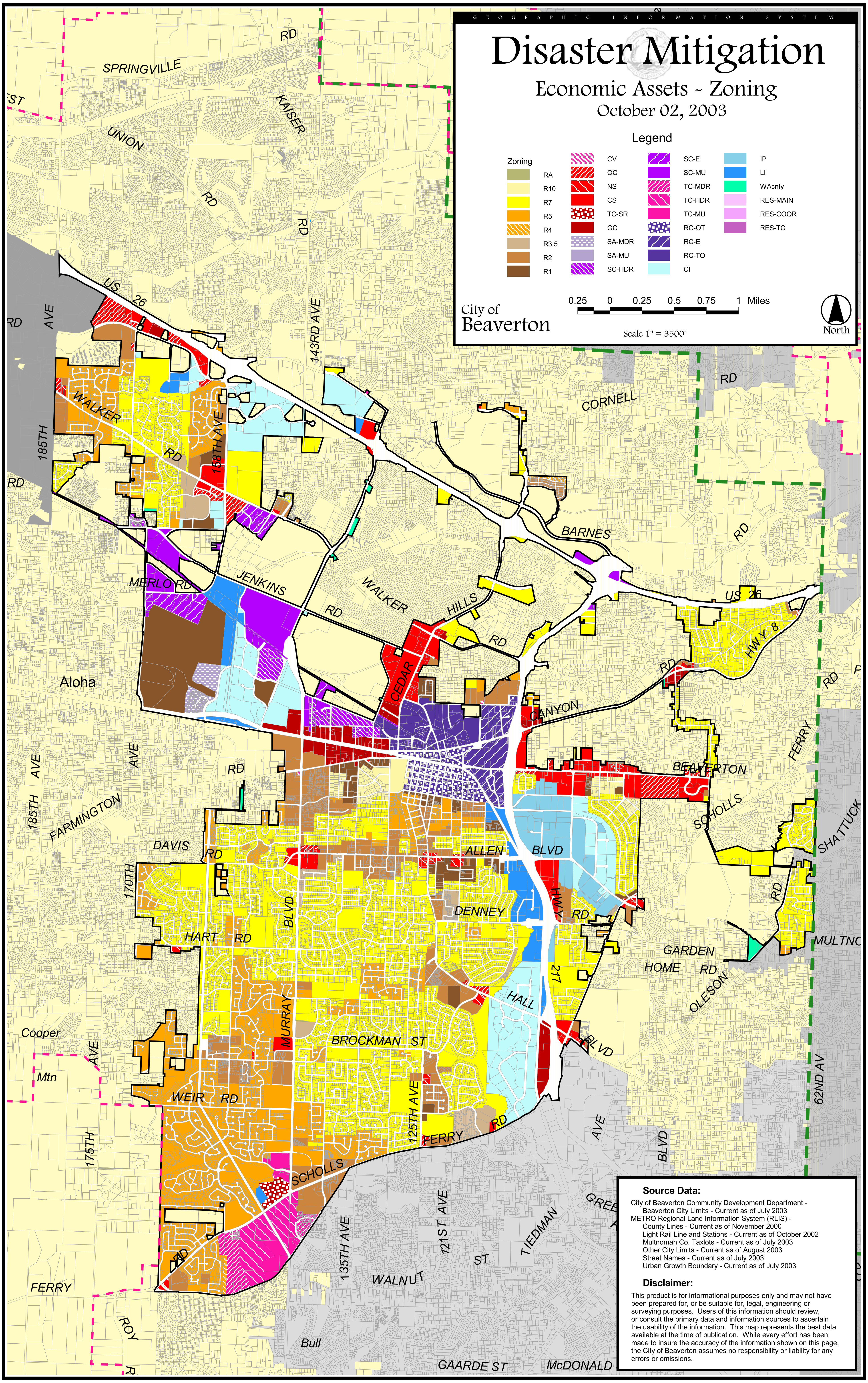
McDONALD
GAARDE ST
FERRY


GEOGRAPHIC INFORMATION SYSTEM
Disaster Mitigation
Economic Assets ~ Zoning
October 02, 2003
Legend
Zoning
RA
R10
R7
R5
R4
R3.5
R2
R1
CV
OC
NS
CS
TC-SR
GC
SA-MDR
SA-MU
SC-HDR
SC-E
SC-MU
TC-MDR
TC-HDR
TC-MU
RC-OT
RC-E
RC-TO
CI
IP
LI
WAcnty
RES-MAIN
RES-COOR
RES-TC
City of Beaverton
0.25 0 0.25 0.5 0.75 1 Miles
Scale 1" = 3500'
North
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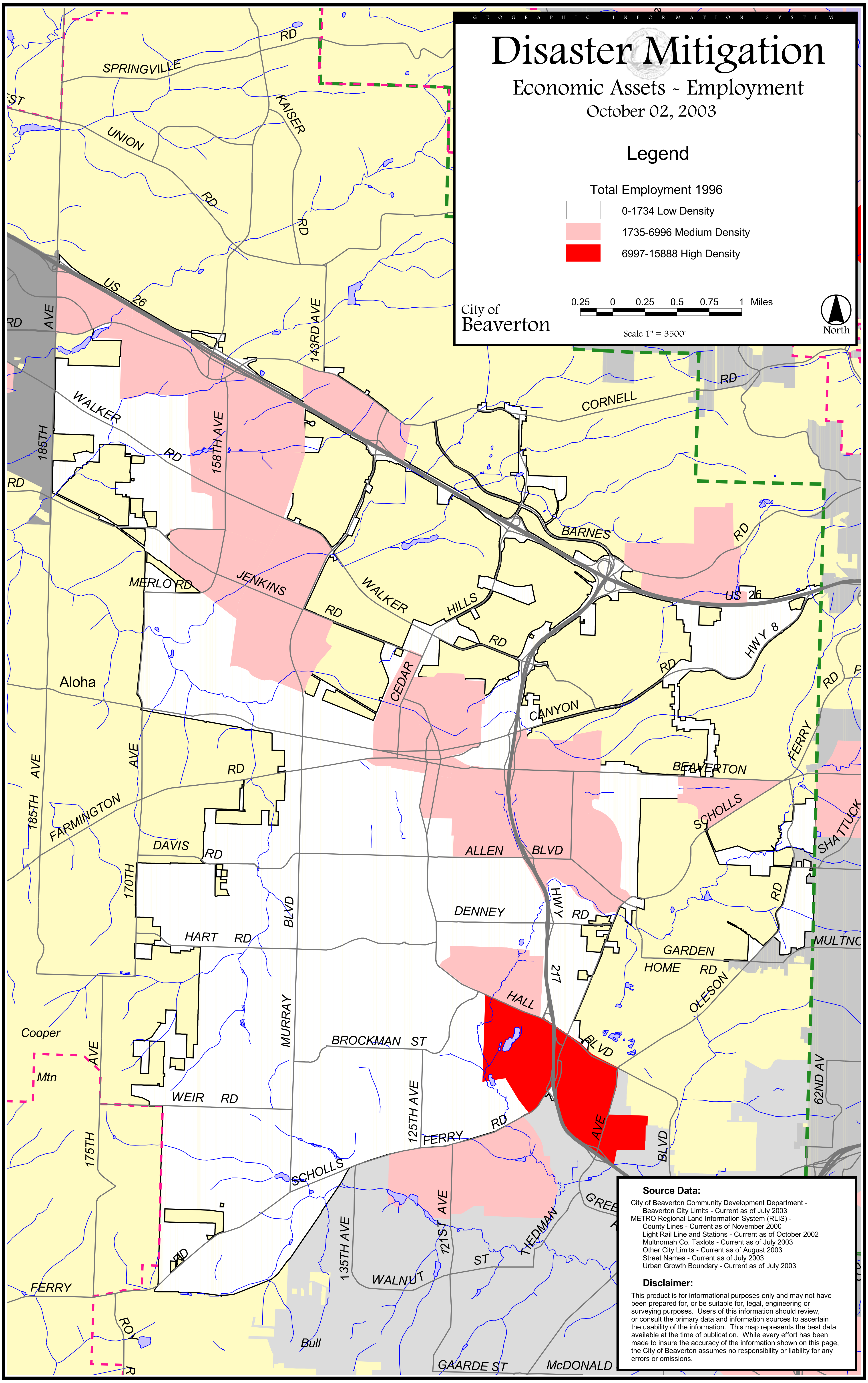

GEOGRAPHIC INFORMATION SYSTEM
Disaster Mitigation
Economic Assets ~ Employment
October 02, 2003
Legend
Total Employment 1996
0-1734 Low Density
1735-6996 Medium Density
6997-15888 High Density
City of Beaverton
0.25 0 0.25 0.5 0.75 1 Miles
Scale 1" = 3500'
North
Source Data:
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DAVIS
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170TH
ALLEN
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HWY
DENNEY
RD
BLVD
HART
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GARDEN
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RD
MULTNO
OLESON
217
HALL
MURRAY
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Mtn
AVE
BROCKMAN ST
BLVD
WEIR
RD
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62ND AV
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AVE
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ST
WALNUT
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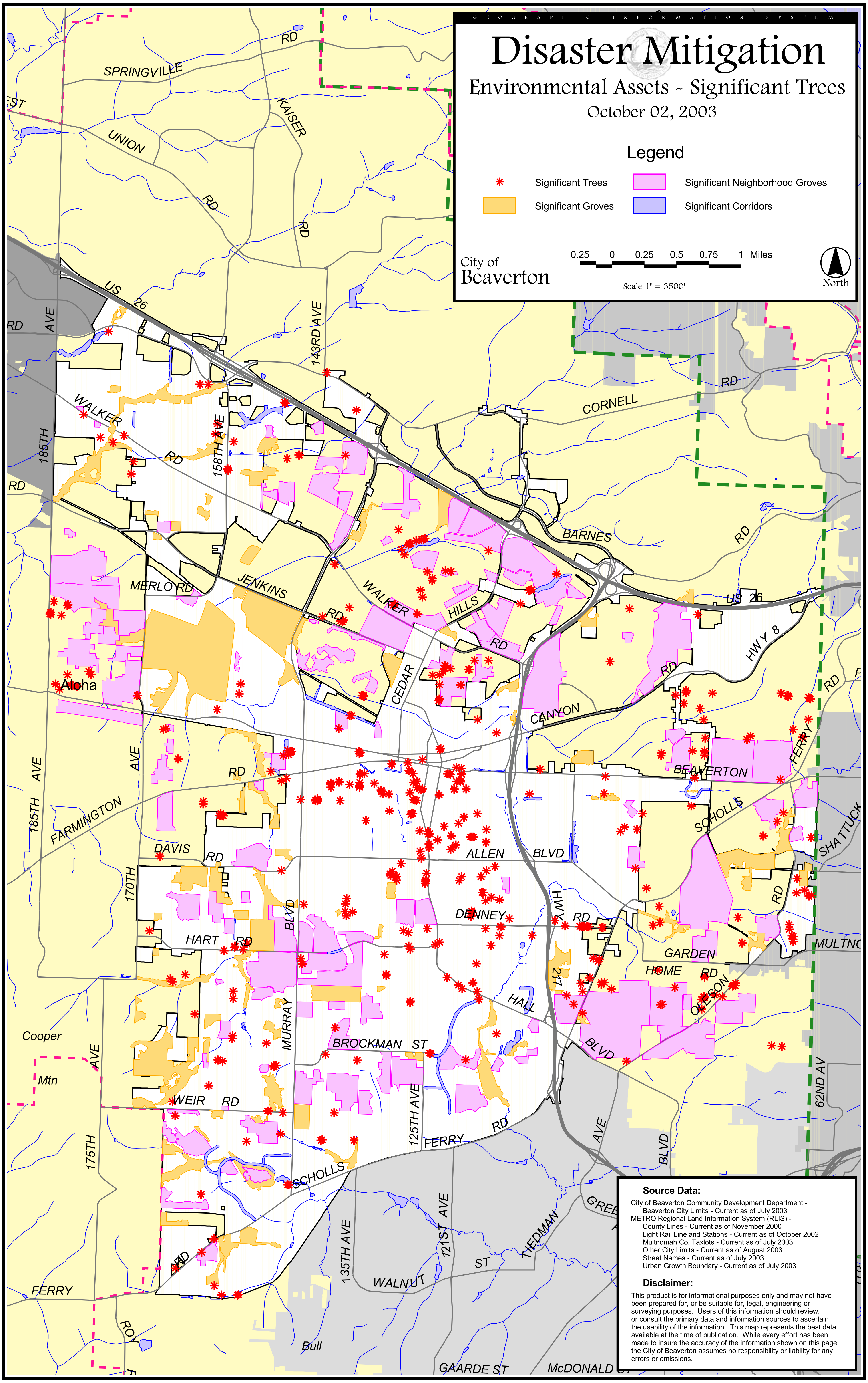
Bull
GAARDE ST
McDONALD




G E O G R A P H I C   I N F O R M A T I O N   S Y S T E M

# Disaster Mitigation

## Environmental Assets ~ Significant Trees

October 02, 2003

### Legend

- Significant Trees
- Significant Neighborhood Groves
- Significant Groves
- Significant Corridors

0.25 0 0.25 0.5 0.75 1 Miles

Scale 1" = 3500'

North

City of Beaverton

**Source Data:**

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Street Names - Current as of July 2003
Urban Growth Boundary - Current as of July 2003

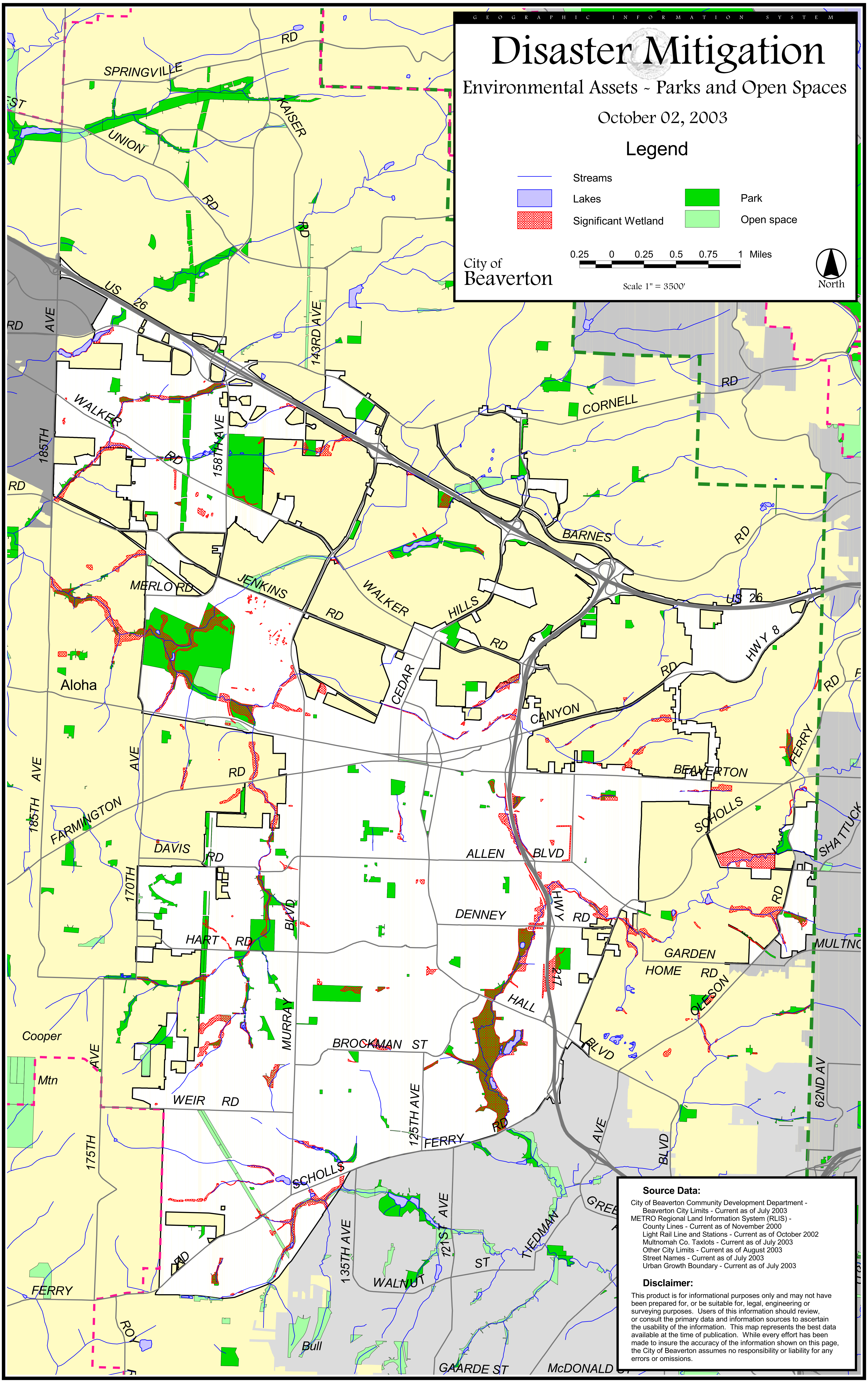
**Disclaimer:**

GEOGRAPHIC INFORMATION SYSTEM

# Disaster Mitigation

## Environmental Assets ~ Parks and Open Spaces

October 02, 2003

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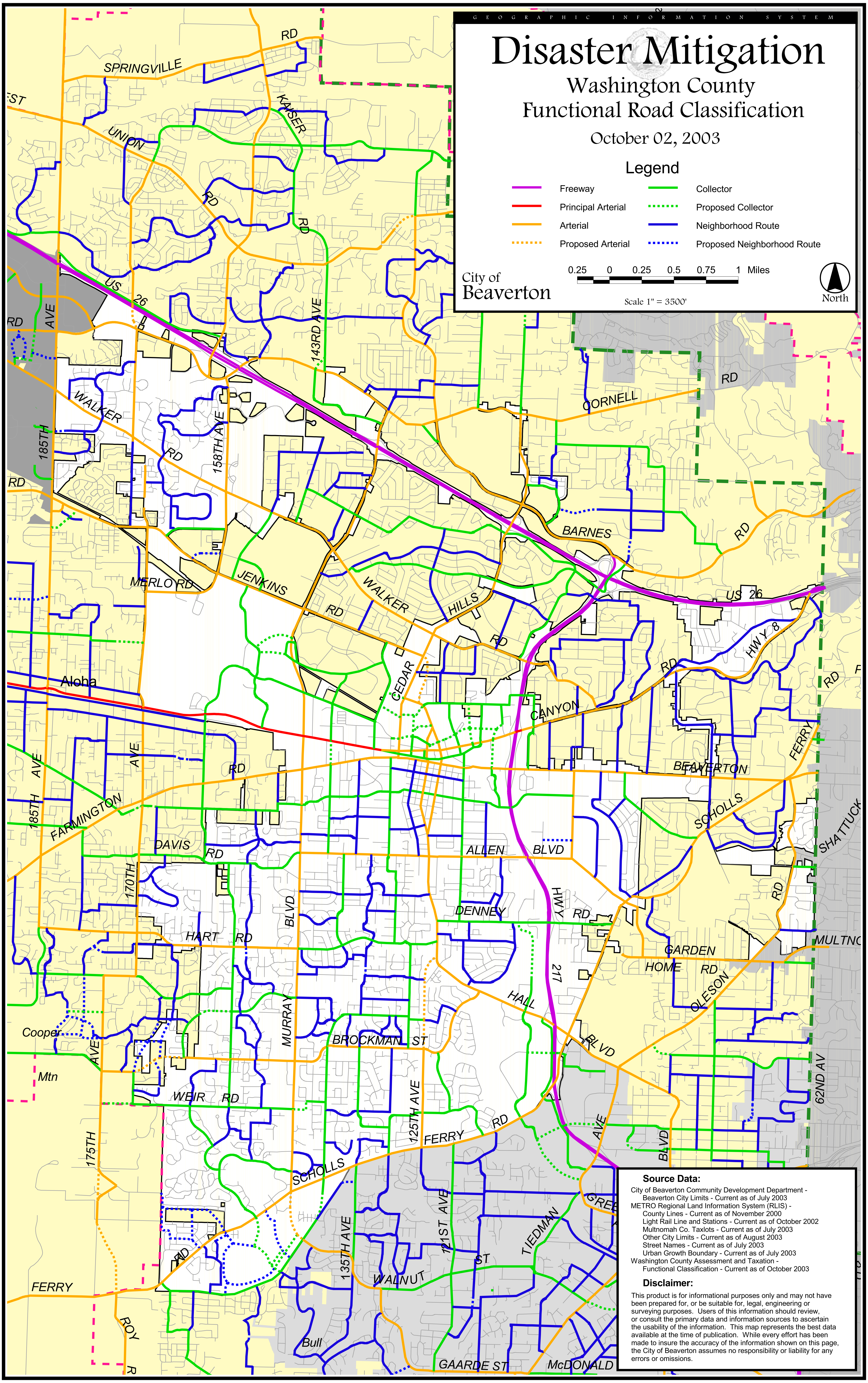
G E O G R A P H I C   I N F O R M A T I O N   S Y S T E M
Disaster Mitigation
Washington County
Functional Road Classification
October 02, 2003
Legend
Freeway
Principal Arterial
Arterial
Proposed Arterial
Collector
Proposed Collector
Neighborhood Route
Proposed Neighborhood Route
0.25 0 0.25 0.5 0.75 1 Miles
Scale 1" = 3500'
City of Beaverton
North
SPRINGVILLE RD
UNION RD
KAISER RD
US 26
185TH AVE
WALKER RD
158TH AVE
143RD AVE
CORNELL RD
BARNES RD
JENKINS RD
MERLO RD
HILLS RD
CEDAR
Aloha
CANYON RD
BEAVERTON
HWY 8
FERRY
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SHATTUCK
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HWY 217
170TH
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MURRAY BLVD
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Washington County Assessment and Taxation -
Functional Classification - Current as of October 2003
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# Chapter 1
# Introduction

The City of Beaverton (the City) developed this Natural Hazard Mitigation Action Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

A natural disaster occurs when a natural hazard impacts people or property and creates adverse conditions within a community. Natural hazards include: floods, earthquakes, coastal erosion, tsunami, volcanic eruption, severe winter storm, windstorm, drought, and wildfire, and each has the potential to harm people or property.[1] This plan focuses on the natural hazards which could affect the City of Beaverton, Oregon. Beaverton's topography, the presence of streams, and its proximity to the Cascade Range and the Columbia Gorge play a large role in determining which natural hazards affect the City. Beaverton is subject to and has been affected by flooding, windstorms, severe winter storms, earthquakes, and volcanic eruption in the past. Wildfires or landslides have not significantly impacted Beaverton in the past, but these hazards may become more prominent as the City annexes lands to the northeast and southwest in the future. The historic impacts of these hazards have resulted in economic loss and damaged infrastructure in and around the City.

## Why Develop a Mitigation Plan?

The dramatic increase of the costs associated with natural disasters over the past decades has fostered interest in identifying and implementing effective means of reducing vulnerability. This natural hazard mitigation plan is intended to assist the City of Beaverton in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City. The City received one third of the funds to develop the plan from the Flood Mitigation Assistance (FMA) Program, a Federal Emergency Management Agency (FEMA) grant program. The City of Beaverton provided the additional funds for the plan's development from its General Fund.

In 2000, Congress passed and the President signed the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under this Act and rules published in 44 CFR Part 201.6, states, communities, and tribal governments must complete FEMA-approved natural hazard mitigation plans by December 31, 2004 to be eligible for certain federal assistance programs such as the Hazard Mitigation Grant Program (HMGP).[2]

The plan is non-regulatory in nature, meaning that it does not set forth any new policy. It does however, provide: (1) a foundation for coordination and collaboration among agencies and the public in the City of Beaverton; (2) identification and prioritization of future mitigation activities; and (3) assistance in meeting federal planning requirements and qualifying for assistance programs. The mitigation plan works in conjunction with other City plans and programs including the Comprehensive Land Use Plan, Emergency Response and Recovery Plans, Economic Development Strategic Plan, Capital Improvement Plan as well as the Washington County Natural Hazard Mitigation Plan.

The plan provides a set of actions to prepare for and reduce the risks posed by natural hazards through education and outreach programs, the development of partnerships, and implementation of preventative activities such a land use or watershed management programs. The actions described in the plan are intended to be implemented through existing plans and programs within the City.

This plan is not the first effort the City has undertaken in natural hazard mitigation. The City has undergone a seismic survey of city facilities, developed and routinely conducts public and employee preparedness training, upgraded portions City Hall,[3] upgraded the Operations Facility and had the City's seismic maps updated,[4]

## Why Natural Hazard Mitigation?

What is natural hazard mitigation? Natural hazard mitigation is defined as permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.[5]

Engaging in mitigation activities provides jurisdictions with a number of benefits including reduced loss of life, property, essential services, critical facilities and economic hardship, reduced short-term and long-term recovery and reconstruction costs, increased cooperation and communication within the community through the planning process and increased potential for state and federal funding for recovery and reconstruction projects.

## Who Will the Plan Affect?

The plan affects the City of Beaverton and a portion of its urban service area. This extends from Highway 26 south to Scholls Ferry/Taylor's Ferry Roads and from the Multnomah/Washington County line west to

170th & 185th. The hazard identification includes unincorporated areas already addressed by the city in Statewide Planning Goal 5 studies. Map 1.1 shows the areas involved in this study area boundary. While this plan does not establish mandates for the City, it does provide a viable framework for planning for natural hazards. The resources and background information in the plan are applicable citywide, and the goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships. Recognizing that natural hazards do not start or stop a jurisdiction boundaries, mitigation action items identified in the Beaverton plan overlap with mutual benefit to many actions identified in the Washington County mitigation plan.

## Policy Framework for Natural Hazards in Oregon

Planning for natural hazards is an integral element of Oregon's statewide land use planning program, which began in 1973. All Oregon cities and counties have comprehensive plans and implementing ordinances that are required to comply with the statewide planning goals. The challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide land use planning Goal 7, Planning for Natural Hazards, calls for local plans to include inventories, policies, and ordinances to guide development in hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, resources exist at the state and federal levels. Some of the key agencies in this area include Oregon Emergency Management (OEM), Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI), and the Department of Land Conservation and Development (DLCD).

The Disaster Mitigation Act of 2000 (DMA 2000) is the latest federal legislation addressing mitigation planning. The new legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur. As such, this Act established a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and local levels. It identifies new requirements that allow HMGP funds to be used for planning activities, and increases the amount of HMGP funds available to states that have developed a comprehensive, enhanced mitigation plan prior to a disaster. States and local communities must have approved mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that their proposed mitigation measures are based on a sound planning process that accounts for the risk to the individual and their capabilities.

# Plan Methodology

The Beaverton Natural Hazard Mitigation Plan was developed using a planning process created by the Oregon Natural Hazard Workgroup at the University of Oregon. The planning process was designed to (1) result in a plan that is DMA 2000 compliant, (2) coordinate this plan with the Washington County Natural Hazard Mitigation Plan[6], and (3) build a network of jurisdictions and organizations that can play an active role in plan implementation. Following is a summary of major activities included in the planning process.

***Steering committee input***: The project steering committee convened approximately every 6 to 8 weeks (a total of 9 meetings) to guide the development of this plan. The committee played a vital role in developing the goals and action items for the mitigation plan. The committee consisted of representatives of public and private agencies and organizations in the City of Beaverton, including:

- City of Beaverton Emergency Management Program
- City of Beaverton Community Development Department/Planning Services
- City of Beaverton Mayor's Office
- City of Beaverton Operations and Maintenance Department
- City of Beaverton Engineering Department
- City of Beaverton Community Development/Building Division
- City of Beaverton Information Systems Department/Geographic Information Systems Services
- Office of Consolidated Emergency Management
- Portland General Electric
- American Red Cross
- Beaverton Chamber of Commerce
- Oregon Emergency Management

***Stakeholder Interviews:*** Community Planning Workshop (CPW) conducted interviews with individuals and specialists from organizations with natural hazard mitigation responsibilities in and around Beaverton. A complete listing of stakeholders is located in Appendix A. The interviews provided insight on community issues related to natural hazards and a laundry list of current mitigation activities that are being implemented by the various organizations. Interviewed stakeholders included representatives from:

- City of Beaverton Departments

- Watershed Councils
- Water Providers
- School Districts
- Fire Departments
- Utility Providers
- Insurance Industry
- Relief Organizations
- Local Businesses

***State and federal guidelines and requirements for mitigation plan:*** CPW reviewed natural hazard mitigation plans from other jurisdictions, current FEMA planning requirements, the FEMA Flood Mitigation Assistance Program requirements, and the National Flood Insurance Program's Community Rating System. Statewide reference materials consisted of community and county mitigation plans, including:

- Washington County Natural Hazard Mitigation Plan;
- Clackamas County Natural Hazard Mitigation Plan;
- Metro's Regional Hazard Mitigation Policy and Planning Guide;
- *Planning for Natural Hazards: Oregon Technical Resource Guide* (DLCD);
- State of Oregon Natural Hazards Mitigation Plan (OEM); and
- Post-Disaster Hazard Mitigation Planning Guidance for State and Local Governments (OEM)

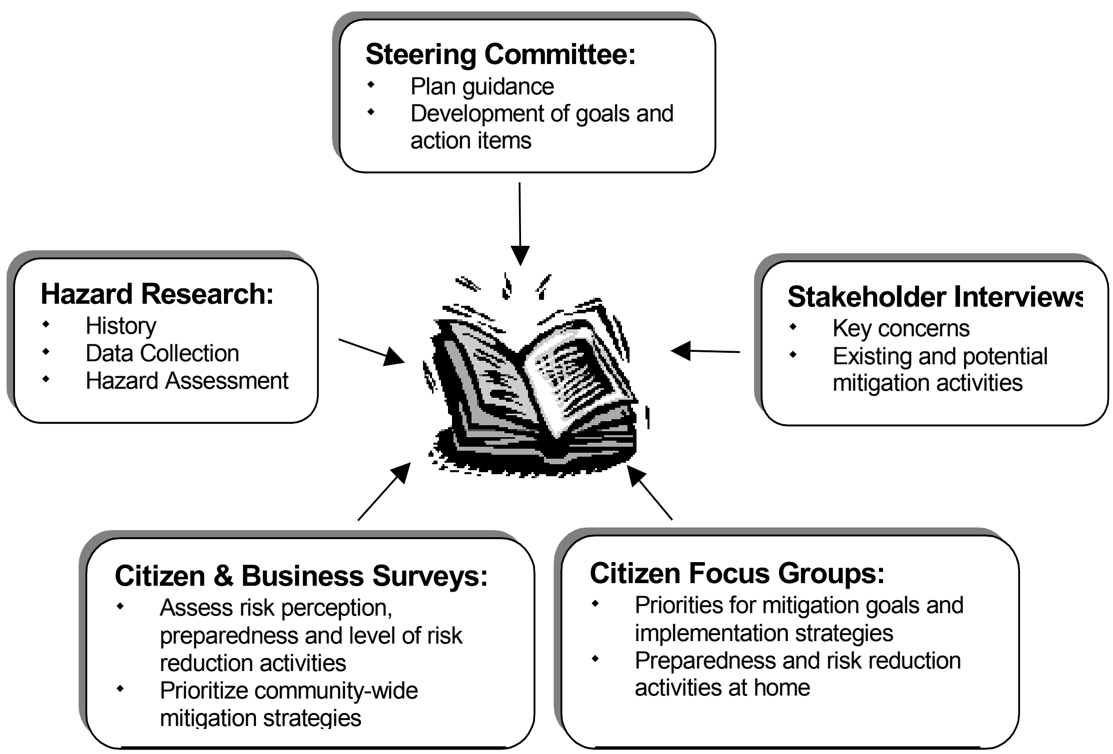
***Hazard specific research:*** CPW collected data and compiled research on six hazards: flood, severe weather, earthquake, volcanic eruption, wildfire, and landslide. Research materials came from state agencies including OEM, DOGAMI, DLCD, BCD, and ODF. Historical local newspapers served as the main source of information on the past impacts of hazards in the community. CPW identified current mitigation activities, resources and programs, and potential action items from research material, input from the steering committee and stakeholder interviews.

***Citizen and Business Risk Perception Survey:*** CPW developed and administered a risk perception survey in the City of Beaverton in January and February of 2003. The purpose of the survey was to gain an understanding of citizen and business levels of preparedness as well as whether or not they have taken steps to reduce risk. The survey also asked citizens and businesses to prioritize community wide preparedness and risk reduction activities. CPW received 320 household surveys and 366 business surveys. Results of the Surveys are noted in Appendixes B and C.

***Citizen Focus Groups:*** CPW developed and implemented a series of three citizen focus groups in mid-April 2003. The purpose of the focus groups was two fold: (1) to facilitate a discussion about what citizens have done to prepare for and/or reduce the risks posed by natural hazards at their home and (2) to facilitate an activity aimed at prioritizing community-wide goals and preparedness and risk reduction activities. Two recruitment strategies were used to get participants for the focus groups. One strategy invited the respondents of the survey to volunteer to participate and the other used existing neighborhood association committees as a means of spreading the word about the focus groups. A total of 14 people attended and participated in the 90-minute focus groups. Appendix D contains information on the Focus Group process.

The resources and information cited in the mitigation plan proved a strong local perspective and helped identify strategies and activities to make the City of Beaverton more disaster resistant and resilient. **Figure 1-1** shows the mitigation planning process components and the key outcomes.

### Figure 1.1. Hazard Mitigation Planning Process



# Methodology for Prioritizing Plan Action Items

To prioritize the plan's action items the City of Beaverton utilized a multi-tiered approach. First the plan goals were prioritized. Second, the natural hazards identified in the community were prioritized based on the hazard risk assessments used in the City of Beaverton's Business Continuity Plan (BCP). Using the outcome of these two activities each action item was tallied according to a point system in a third step in order to determine its relative priority within the plan. The prioritized list of action items serves simply as a starting point for the implementation of mitigation activities.

The Hazard Mitigation Steering Committee and the leadership of the City of Beaverton have the option to implement any of the action items at any time. This allows the committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of highest priority. The following is the method by which the Hazard Mitigation Steering Committee will prioritize the plan action items.

## Step One: Prioritizing Plan Goals

To accomplish this task the Hazard Mitigation Steering Committee examined and voted on the importance of each of the plan's four goals. The steering committee was led through a "dot prioritization" activity to determine the relative priority of each goal. Steering committee members were given 4 different colored adhesive "dots". Each "dot" had a number assigned to it ranging from 1 to 4 points (four being the highest value). They were asked to place a single "dot" on each of the plan goals, whereby ranking the importance of each goal in making Beaverton more disaster resilient. The steering committee was asked to rank the goals regardless of how easy each goal would be to accomplish. After the vote, their priorities, the "dots" and their associated points were tallied and the results are as follows:

**Highest Priority** (31 Points) – Goal 1: Develop and Implement Activities to Protect Human Life, Commerce, Property and Natural Systems

**2nd Highest Priority** (23 Points) – Goal 4: Ensure Implementation of Mitigation Activities

**3rd Highest Priority** (16 Points) – Goal 3: Enhance Emergency Services

**4th Highest Priority** (10 Points) – Goal 2: Improve Partnerships for Communication and Coordination

## Step 2: Prioritizing Community Hazards

The second step in prioritizing the plan's action items was to examine which hazards they are associated with and where these hazards rank in terms of community risk.

To rank the hazards, City of Beaverton's Business Continuity Plan's (BCP) risk assessment and its methodology was utilized. This risk assessment identified various hazards, both man-made and natural, that may threaten Beaverton's city facilities. The risk assessment examined each of these hazards based on impact, probability, speed of onset, and duration. A formula was used to produce an overall score for the hazards risk. According to this analysis, the hazards identified in this plan were ranked in the following order or priority: Flood, Earthquake, Severe Weather, Landslides, Volcanic Eruption, and then Wildfire.[7]

## Step 3: Tallying the Priorities of Plan Goals and Hazards

A prioritized list of action items were developed based on how the goals and hazards were ranked in Steps 1 and 2. In developing the prioritized list – each action item was examined according to the plan goals addressed[8] and what priority those goals were assigned. In this first step, action items were assigned the following number of points for addressing each goal.

4 Points – Goal 1: Develop and Implement Activities to Protect Human Life, Commerce, Property and Natural Systems

3 Points – Goal 4: Ensure Implementation of Mitigation Activities

2 Points – Goal 3: Enhance Emergency Services

1 Point – Goal 2: Improve Partnerships for Communication and Coordination

Action items that address multiple goals were assigned points for all of the goals that they address.

Depending on which hazards each action item addresses the following point system will be assigned to each:

10 Points – Multi-Hazard

6 Points – Flood

5 Points – Earthquake

4 Points – Severe Weather

3 Points – Landslides

2 Points – Volcanic Eruption

1 Point - Wildfire

Multi-Hazard action items are assigned the most points due to the fact they address multiple hazards.

The points assigned to each action item depend on which hazard they address. These points are then combined with the points assigned to each item based on the goals addresses as detailed in step one to arrive at an Action Item Priority Score noted in the Action Item Matrix included in the Executive Summary. Higher scores indicate higher priorities. The point totals for step one were combined with the point totals in step two to create a number by which each action item is prioritized.

The one action item which does not follow this prioritization process is Multi-Hazard Short Term Action Item #1: *Establish a Beaverton Natural Hazards Mitigation Committee to facilitate implementation, monitoring, and evaluation of citywide mitigation activities.* This action item is instead placed as the first priority because it is seen as crucial to ensuring plan implementation.

### Step 4: Action Item Implementation

Along with the prioritized Action Item Matrix, a Capability Assessment Matrix is also included and is found in the Executive Summary. The blank Capability Assessment is included for the Emergency Management Program along with Beaverton's Natural Hazards Mitigation Plan Steering Committee. This Capability Assessment is designed to assess the operations, readiness, and capabilities of those organizations associated with the plan's action items to assess which items in the prioritized list can be implemented using existing resources and which items require outside funding. The concept of the Capability Assessment is to further refine how and when the plan's actions items are implemented based on the implementing organization's capability.

Beaverton's Natural Hazards Mitigation Committee, headed by OCEM, will administer the implementation of action items with overall guidance of the City of Beaverton.

In examining the feasibility of the plan's prioritized action items benefit-cost analysis will be encouraged for all structural mitigation projects. See Appendix E for more information on this process.

## Plan Organization

### How do I use the plan?

Each section of the mitigation plan provides specific information and resources to assist people in understanding the City and the hazard-specific issues facing citizens, businesses, and the environment. Combined, the sections work together to create a mitigation plan that guides the mission to reduce risk and prevent loss from future natural hazard events. This plan structure enables people to use the section(s) of interest to them.

#### Volume I: Mitigation Action Plan

***Executive Summary: Five-Year Action Plan***

The *Five-Year Action Plan* provides an overview of the mitigation plan mission, goals, and action items. The plan action items are included in this section, and address multi-hazard issues, as well as hazard-specific activities that can be implemented to reduce risk and prevent loss from future natural hazard events.

#### *Chapter 1: Introduction*

The Introduction briefly describes historical events that have impacted the area, mitigation planning, and the methodology used to develop the plan. It also includes information about the steering committee's role, how stakeholders provided input, and finally, the role of the public.

#### *Chapter 2: Community Profile*

The Community Profile describes the City in terms of demographic, economic, and development trends as well as geography and environment, housing and transportation.

#### *Chapter 3: Risk Assessment*

The Risk Assessment illustrates the three phases of risk assessment, which include: identifying hazards, assessing vulnerabilities, and estimating potential losses.

#### *Chapter 4: Mitigation Plan Goals, Action Items and Public Participation*

This section provides information on the process used to develop the goals and action items in the plan. It also describes the framework that focuses the plan on developing successful mitigation strategies.

#### *Chapter 5: Plan Implementation and Maintenance*

This section provides information on the implementation, monitoring and evaluation of the plan.

#### *Chapter 6: Multi-Hazard Action Items*

This section provides information on goals and action items that address all the natural hazards in the mitigation plan.

### Volume II: Hazard Specific Information

Four chronic hazards and two catastrophic hazards are addressed in this plan. Chronic hazards occur with some regularity and may be predicted through historic evidence and scientific methods. The chronic hazards addressed in the plan include:

- *Chapter 7: Flood*
- *Chapter 8: Severe Weather*
- *Chapter 9: Landslide*
- *Chapter 10: Wildfire*

Catastrophic hazards do not occur with the frequency of chronic hazards, but can have devastating impacts of life, property, and the environment. The two catastrophic hazards presented in the plan are:

- *Chapter 11: Earthquake*
- *Chapter12: Volcano-Related Events*

Each of the hazard specific sections includes information about historical impacts, risk assessments, specific community issues, goals and action items, and local resources associated with the hazard.

## Volume III: Resources

The plan appendices are designed to provide users of the City of Beaverton Natural Hazard Mitigation Plan with additional information to assist them in understanding the contents of the mitigation plan, and potential resources to assist them with implementation.

### *Appendix A: Public Participation*

This appendix includes specific information on the various public processes used during development of the plan.

### *Appendix B: Household Natural Hazards Preparedness Survey*

This section describes the results of the household risk preparedness survey including the methodology, limitations, response rate, responses and open-ended remarks.

### *Appendix C: Business Preparedness Survey*

This section describes the results of the business risk preparedness survey including the methodology, limitations, response rate, responses and open-ended remarks.

### *Appendix D: Focus Group Results*

This section describes the results of the focus group exercise designed to follow up on the Household Natural Hazards Preparedness Survey. The section includes the methodology, activities and results of the community focus groups.

### *Appendix E: Economic Analysis of Natural Hazard Mitigation Projects*

This section describes the Federal Emergency Management Agency's (FEMA) requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

### *Appendix F: List of Acronyms*

This section provides a list of acronyms for city, county, regional, state and federal agencies and organization that may be referred to within the City of Beaverton Natural Hazard Mitigation Plan.

## Section Endnotes

[1] Federal Emergency Management Agency. 2002. *How-To Guide #2: Understanding Your Community's Risks; Identifying Hazards; and Determining Risks.*

[2] DMA 2000, State and Local Plan Criteria: Mitigation Planning Workshop for Local Governments,

<http://www. fema.gov/fima/planning_toc4.shtm>

[3] Metro Regional Government. Survey of Natural Hazard Mitigation Practices of Cities and Counties in the Portland, Oregon Metropolitan Region. 1997. http://hazards.metro-region.org/mapoptix_hazards/adobe_docs/guide-app3.pdf Accessed 9/3/02

[4] Department of Geology and Mineral Industries. www.oregongeology.com/news&events/archives/9649-rel.htm Accessed 9/3/02

[5] Massachusetts Department of Environmental Management. 1999. "Hazard Mitigation: Managing Risks, Lowering Costs. http://www.state.ma.us/dem/programs/mitigate/whatis.htm Accessed 8/2/02

[6] To preserve the ties between the Washington County Plan and the City of Beaverton plan, some information and text found in this plan was taken directly from the Washington County Plan.

[7] The formula for calculating the risk assessment takes the probable level of impact an event may have (I), multiplied by the probability of the event occurring in any given year (PR), multiplied by the possible duration of the event (D) and divided by how quickly the event will occur (S):

$$\frac{I \times PR \times D}{S}$$

Some adjustments for aspects of this formula were made by the City's Emergency Management Program to best reflect the hazards described in Beaverton's Natural Hazard Mitigation Action Plan.

For example, for wildfire (listed as external fire in the Business Continuity Plan (BCP)), the numbers were re-run to include the entire city of Beaverton coming up with a score of 8 (I = 2, PR = 2, S = 2, D = 4) rather than the 1 that is in the BCP.

Also, landslide was not included in the original BCP analysis so utilizing the formula a score of 24 (I=3, PR=2, S=1, D=4).

Lastly, flooding as it is assessed in the BCP is not a good representation of City wide because parts of the city flood at least every other year. Based on this the Emergency Manager reran flood using a 50% probability and came up with a rounded up score of 267.

For more information on Beaverton's BCP contact Beaverton's Emergency Manager at emergmngmail@ci.beaverton.or.us , (503) 642-0383, and http://www.ci.beaverton.or.us/departments/emergency/.

[8] The Hazard Mitigation Steering Committee had previously identified which goals were covered by which action items.

# Chapter 2
# Community Profile

## Why Plan for Natural Hazards in Beaverton?

In 2000, Congress passed and the President signed the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under DMA 2000 and rules published in 44 CFR Part 201.6, communities, states, and tribal governments must complete FEMA-approved natural hazard mitigation plans by December 31, 2004 to be eligible for certain federal assistance programs such as the Hazard Mitigation Grant Program (HMGP).[1]

Additionally, while the City of Beaverton's climate is generally mild and its terrain gentle in its relief, natural hazards do pose a threat to the city's economy and its citizen's property and health. As noted in the following chapter, natural disasters have caused major problems in Beaverton in recent history. Heavy winter rainstorms and windstorms, along with occasional severe winter storms, pose a threat to the City. Beaverton's location near a major earthquake subduction zone places it in danger of experiencing significant earthquake damage, and its proximity to the Cascade mountain range raises the threat of volcanic eruption. Planning for the occurrence of these hazards will help strengthen vital components of the city's infrastructure and minimize the risk and incidence of personal injuries, fatalities, and property damage.

## History of Natural Hazards in Beaverton

The City of Beaverton is directly affected by a number of natural hazards including: windstorms, severe winter storm, flood, volcanic eruption and earthquake. Potential impacts from wildfire and landslides are limited in the City because Beaverton lacks a true wildland-urban interface and has minimal development on slopes. However, future annexation and development may increase the city's exposure to these hazards. The following section will describe a brief history of natural events that have significantly impacted Beaverton.

On October 12, 1962, the largest windstorm in recorded history hit Oregon. The infamous "Columbus Day Storm," the most powerful non-tropical storm to hit the lower-48 states, blasted all of western Oregon. Beaverton's neighbor, Hillsboro, recorded wind gusts of up to 90 mph. In terms of both human life and property, the Columbus Day Storm was by far the most costly to the City of Beaverton, Oregon residents and the entire Northwest. The storm claimed 23 lives and caused $235 million (1962 dollars) in property damage throughout the Northwest.

The most recent windstorm to hit Beaverton occurred December 12, 1995. While this storm was not as powerful as the Columbus Day

Storm, it still caused significant property damage and claimed four lives in the state. Maximum gusts during 1995 storm measured between 70-80 mph in the greater Beaverton area. Other windstorms that caused major damage throughout Beaverton occurred in October 1967; January 1971; November 1981; November 1982, and January 1991.

Winter storms of snow and ice do not commonly occur in Beaverton. However, when they do occur, they can cause significant damage. Heavy snow and icefall contribute to downed limbs, trees, and telephone lines, as well as power outages. The most recent significant winter storm to hit Beaverton occurred in December 1999. Other winter storms that caused significant damage in Beaverton happened in January, 1962; January 1969; January 1979; January 1980; December 1983; February 1989; December/January 1991; January/February 1993; November 1996; and December 1999.

Flooding is a common occurrence in Beaverton that presents a threat to both property and human life. Although the City does not contain any rivers, there are a number of creeks within the city limits.[2] Historically, Beaverton has had substantial flood problems predominately from Beaverton, Fanno, Johnson, and Cedar Mill creeks. A significant flood occurred in 1996, with the majority of the flood damage occurring near the intersection of State Highway 217 and State Highways 8 (Canyon Road/Tualatin-Valley Highway) and 10 (Beaverton/Hillsdale Highway/Farmington Road). Much of the flood damage that has occurred in Beaverton has impacted structures in both the Beaverton and Fanno Creek floodplains.

Another major natural hazard that Beaverton has had to contend with is volcanic eruption. Mount Saint Helens and Mount Hood are both active volcanoes within the vicinity of Beaverton, each lying approximately 50 miles away. Historically, Mount Hood has had two significant eruptive periods, one about 1,500 years ago and another about 200 years ago.[3] Mount Saint Helens has been active throughout its 50,000-year lifetime, and last erupted on May 18, 1980. The eruption resulted in ash fall in and around Beaverton, which created a significant health hazard to residents.

Earthquakes are another hazard of concern for Beaverton residents. On February 28, 2001, Beaverton residents felt a 6.8 magnitude earthquake centered near Anderson Island, in Pierce County, Washington. Local damage from that earthquake was limited, but it served as an important reminder of the potential that Beaverton has for sizeable earthquakes. Portland and its surrounding areas have recorded several earthquake events, including a 5.3 magnitude earthquake in 1877, a 5.5 magnitude earthquake in 1962, and a 5.5 magnitude earthquake in 1993.[4] Oregon ranks third in the nation for potential earthquake losses, which are expected to exceed $12 billion in the event of a Cascadia Region Subduction Zone earthquake.[5] Although the faults in Beaverton and elsewhere in Washington County are currently considered inactive, the location of the faults, slope instability, and the prevalence of certain soils in the city that are subject to liquefaction and amplification make it highly prone to potential loss from future earthquakes.

While wildfire and landslides have had less of an impact on city residents, they still pose significant risk in terms of potential occurrence and loss as the city continues to grow. Wildfires are a natural part of the ecosystem in Oregon and present a substantial hazard when threatening life and property in growing communities. While the city may not share a boundary with a large forest, there are four natural area parks within the city totaling over 300 acres. The largest park is the Tualatin Hills Nature Park adjacent to the Merlo light rail station. Areas with steep slopes, which have the potential for landslides and debris flows, occur within the city's Urban Service Area.

Beaverton's past experiences with natural hazards serve as important lessons about the potential impacts of future events. The potential threat from any one of these events points to the importance of planning for and reducing the risks posed by natural hazards.

# Geography and Environment

The City of Beaverton abuts the City of Portland, Oregon, in Washington County. Washington County extends from Beaverton's east side to the northern Oregon Coast Range in the west and is part of the Portland metropolitan area, which includes Multnomah, Clackamas, and Washington Counties. The dominant natural feature in Washington County is the Tualatin River, which forms the agriculturally rich Tualatin Valley. The county is also bordered by four mountain ranges: the Coast Range to the west, the Tualatin Mountains to the north, the West Hills of Portland to the east, and the Chehalem Mountains to the south.

Beaverton's terrain is predominately flat or rolling hills, with an average elevation of 189 feet. There are two prominent features around Beaverton: Portland's West Hills, which are to the northeast of Beaverton, and Cooper Mountain, elevation of 730 feet, to the southwest.[6] Mount Williams, elevation of 471 feet in west Beaverton, and Sexton Mountain, elevation of 413 feet in southwest Beaverton, are two moderate features that create visual relief in the landscape. Maps of Beaverton's Environmental Assets showing the community's parks and open space as well as significant trees are located in this plan's map section.

## Rivers and Streams

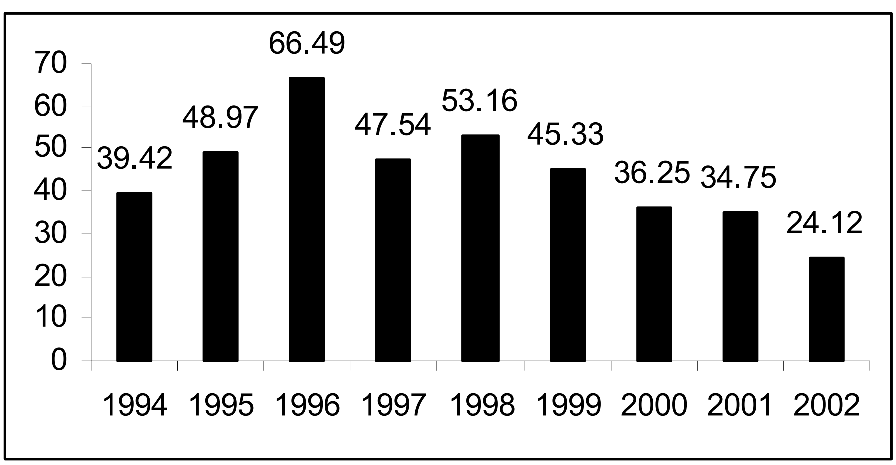
Beaverton is a fast-growing community with considerable areas of present and potential development adjacent to waterways. Although the city does not contain any rivers, a number of creeks run through it that have a tendency to flood during heavy rains. Beaverton Creek, the most significant stream in the City, drains approximately 36 square miles as it flows through the City's major commercial center. Numerous wetlands surround Beaverton Creek, which help control runoff and prevent flooding, but flooding continues to present a hazard to structures located near the stream. Fanno Creek runs through eastern Beaverton from the West Hills, under Highway 217, and then south to Tigard.[7] Fanno Creek presents erosion and flooding hazards to properties on its banks. In December 1996, flooding from Fanno Creek caused the closure of Highway 217, a major north-south transportation route.[8]

As Beaverton has grown, hydrology has been altered by development, which increases runoff from impervious surfaces and can be accompanied by problems like erosion and flooding. Some stream segments in the city have been enclosed in culverts, including a portion of Beaverton Creek that passes beneath the parking lot at City Hall and the Beaverton Town Square shopping center.

## Climate

The climate in Beaverton is mild year-round. Beaverton has a modified marine climate, with most of the weather coming from the Pacific Ocean. The Cascade Mountains to the east help prevent colder continental air from influencing temperatures in the winter. However, arctic air masses occasionally move from the east through the Columbia River Gorge, which result in freezing rain and snow. Large Pacific storms that bring high winds and heavy rain also hit the area, particularly in winter. Beaverton receives approximately 39.4 inches of rain per year[9], most of which falls from October through April, with December being the wettest month of the year. The average annual low is 33 degrees Fahrenheit, which occurs in January. The average annual high is 81 degrees Fahrenheit occurring in August. Average humidity ranges from 82% in the winter to 62% in the summer.[10] Figure 2.1 shows the annual rainfall in inches for Beaverton from 1994 to 2002. Complete precipitation data was not available for 1989 through 1993.

**Figure 2.1 Annual Precipitation, Beaverton, Oregon, 1994 – 2002**




Source: Oregon Climate Service
*1997 – data missing one day of data
**2002 – data missing three days of data

## Minerals and Soils

Several common natural hazards are related to soil stability and water retention. These hazards include landslides, erosion, flooding, and liquefaction resulting from an earthquake. Mineral and soil compositions are important factors for determining whether Beaverton is prone to hazards such as landslides. The soils in Washington County include "semi-consolidated sedimentary rocks, basaltic lavas, marine sedimentary rocks, and Eocene Age volcanic and sedimentary rocks."[11] The soils in Beaverton fall into three general soil associations, which are one or more component soils combined with associated landscape characteristics. The main soil association in Beaverton is the Aloha-Amity-Dayton Association. This is a silty or clayey poorly draining soil and is found in flood plains and bottomlands. Natural vegetation linked with this soil type includes Oregon white oak, low shrubs, and grasses. Sedimentation risk is low, but pooling of water during wet months is likely.[12] In southern Beaverton, the soil changes into the Woodburn-Quatama-Willamette Association. These soils are also found in lowlands, but they are silty, and moderately well drained. Sedimentation risk in this soil association is moderate to high. Associated natural vegetation includes Douglas fir, Oregon white oak, and shrubs. The third major soil type in Beaverton is that of the Cascade-Cornelius Association. These soils are found in the hills of Beaverton, in very steep to gently sloping areas. Formed from loess and alluvium, the Cascade-Cornelius Association ranges from somewhat poorly drained to moderately well drained. The vegetation on this soil type includes Douglas fir, big-leaf maple, western red cedar, shrubs, and grasses. Sedimentation risk from runoff on this soil type is high.

## Significant Geological Factors

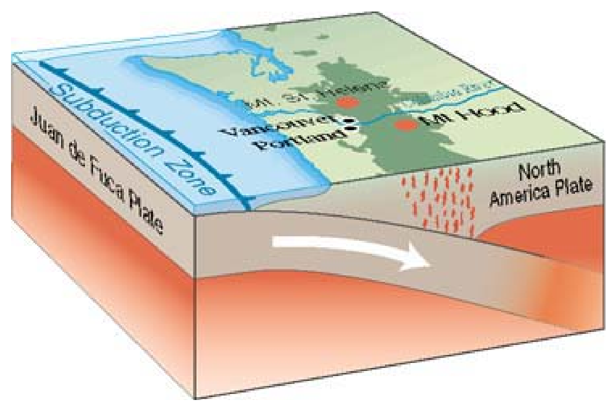


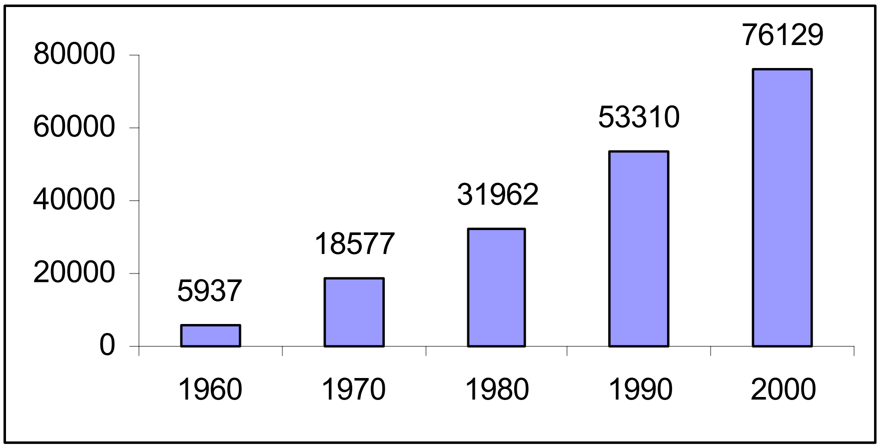

Figure 2.2 Cascadia Region Subduction Zone

Most of the Pacific Northwest lies within the Cascadia Subduction Zone, where the Juan de Fuca and North American plates meet. The convergence of these tectonic plates puts most areas of western Oregon and Washington at risk for a catastrophic earthquake with a magnitude of 8.0 or higher. Beaverton lies in this area of risk. Another earthquake risk for Beaverton is the Portland Hills fault, which may be capable of generating moderately large earthquakes. As a result of the subduction zone, there are active volcanoes nearby, including Mt. St. Helens in southwest Washington, and Mt. Hood. Major eruptions of these volcanoes may cause significant ash fall in the Beaverton area.

# Population and Demographics

According to the 2000 Census, Beaverton's population in 1990 was 53,310; by the year 2000, the population had grown to 76,129 resulting in a 42% growth rate during that decade.[13] Figure 2.3 illustrates Beaverton's population from 1960 to 2000. By the year 2015, Beaverton's population is expected to increase to 86,900.[14]

**Figure 2.3. Historic Population Trends, Beaverton, 1960 – 2000**




Source: Metro, 2015 Regional Forecast and Urban Development Patterns February 1996.

While natural hazards do not discriminate, the impacts in terms of loss and the ability to recover vary greatly among those affected.[15] According to Peggy Stahl of the FEMA Preparedness, Training and Exercise Directorate, 80% of the disaster burden falls on the public. Women, children, minorities and the poor bear a disproportionate amount of this burden because of misunderstandings of FEMA's role in disaster relief.[16] Because women, children, minorities, and the poor are especially at risk during disasters, it is important to identify those populations within Beaverton. Potential language, economic, physical, and social barriers could inhibit disaster preparedness and limit the efficacy of relief efforts during a disaster.

In Beaverton, 9.7% of households are female-headed households. There are approximately 20,906 Beaverton residents below the age of 19; this represents 27.5% of the City's total population. In 2000, 11.1% of Beaverton's population was Hispanic or Latino, 9.7% were Asian and 0.7% was American Indian and Alaska Native. Five percent of Beaverton's families are below the poverty level, at the same time, 14.5% of families with female-headed households are below the poverty level. This climbs to 18.5% with related children under 18 years of age and all the way to 32.3% with related children under 5 years of age.[17]

In 2000, the City of Beaverton conducted a survey of its residents to gather information on housing issues within the City. Survey objectives included housing conditions, housing affordability, population demographics, and commuting habits. A survey was prepared in five languages: English, Spanish, Cambodian, Korean, and Vietnamese. The results of the survey indicate that English is the most common language spoken among the respondents. Spanish is the primary language spoken in 2% of the households. No other language is spoken by more than 1% of respondents. However, there are major differences in some segments. For example, 99% of White Caucasians use English as their primary language, but only 63% of non-Whites use English as their primary language.[18]

## Land and Development

Beaverton is a community of residential, commercial, and industrial uses. Fifty-three percent of the land in the City is designated as "standard density."[19] Beaverton has many commercial centers serving the community's needs. Beaverton Town Square and the Beaverton Mall form two primary shopping areas in Beaverton's downtown for the community. A growing commercial area is the Murray-Scholls Town Center, near the intersection of Scholls Ferry Road and Murray Boulevard. This is an area of compact development and high-quality transit service.

Beaverton's downtown is designated a Regional Center. As such, new development must meet new mixed-used transit-oriented standards. The Round, a mixed-use transit oriented development at the intersection of Watson Avenue and the Westside Light Rail line, has been constructed in phases. The current proposal for the Round includes, 123,500 square feet of retail space, 342,000 square feet of commercial space, 264 residential units, and approximately 810 parking spaces. The development is encouraged by and is designed, in part, to meet regional growth policies that encourage compact mixed-use development in close proximity to transit; this type of development is less land consumptive and provides a high level of pedestrian amenities.[20]

Major employment areas within Beaverton generally include the areas commonly known as the Twin Oaks Industrial Park and Cornell Oaks Corporate Center. A map in this plan's Map Section titled Economic Assets – Employment shows the 1996 employment denisites. Designated industrial areas in Beaverton include Southern Pacific Industrial Park, Allen Business Park, and Bevest Industrial Park developments.[21] The rest of the land in Beaverton is mostly comprised of neighborhoods of varying densities. See this plan's Map Section for the map titled Economic Assets – Zoning for more information and in addition Table 2-1 illustrates the total number of acres and percentages of each land use designation in Beaverton.[22]

**Table 2.1. Land Use Designation, Beaverton, 2002**

| Land Use Designation | Acres | Percentage of Total Acres |
|---|---|---|
| NR-Low Density | 72.3 | 1% |
| NR-Standard Density | 4544.8 | 53% |
| NR-Medium Density | 317 | 4% |
| NR-High Density | 368.5 | 4% |
| Regional Center | 562.9 | 7% |
| Station Community | 350.7 | 4% |
| Town Center | 196.2 | 2% |
| Main Streets | 85.2 | 4% |
| Industrial Area | 435 | 5% |
| Interim Washington County Comprehensive Plan | 72.4 | 1% |
| Corridor | 1247.2 | 14% |
| Employment Area | 354.1 | 4% |
| **Total Acres in Land Use** | **8610.2** | **100%** |

Source: City of Beaverton Community Development Department, GIS Division

## Development Regulations

There are a number of current regulations regarding development in areas subject to natural hazards. The following is a brief outline of the applicable regulations.

Street slope can significantly increase the potential for landslides as well as slow response time for wildfires. Currently, the City's maximum street grade is 15% for neighborhood routes and 10% for all other routes. Grades steeper than 15% are allowed only through approval of a City Engineer. Future annexation of lands in sloped areas may include streets that do not meet current City requirements. Washington County's current maximum allowable grade is 15% for all roads. Exception for grades steeper than 15% must be approved by the Fire Marshal. Some streets in future annexation area may exceed the 10%

requirement for non-neighborhood routes; therefore, the issue of non-compliant roads must be addressed.

There exists a potential conflict between preserving environmental sensitive lands and "buildable" lands in the Urban Growth Boundary (UGB) inventories in the Portland Metro area. Removing environmentally sensitive lands from development infringes on the ability of the jurisdiction to maintain the required 20 years of housing capacity. The Metro Council's Resolution Number 99-2820 "encourages all local jurisdictions in the Metro region to actively protect environmentally sensitive areas, even if they include lands that Metro is required by state law to classify as "buildable" for its UGB inventory."[23] A previous resolution related to the resolution above, 97-2562B, provided similar recommendations to local jurisdictions. The resolution indicates that:

> the protection of environmentally sensitive lands from development could result in a decline in net buildable acres in a local jurisdiction. Upon demonstration by a local jurisdiction that such protection results in an inability to meet jobs, housing and other targets established in the Urban Growth Management Functional Plan, which includes a recommendation which identifies land that would provide for the unaccommodated capacity located inside or outside the urban growth boundary and near or adjacent to the city of county, the Metro Council will grant an exception consistent with Title 8 of the Functional Plan. The exception will be granted to the extent the local jurisdiction establishes that decline in net buildable acres is the result of lands being protected from development by locally adopted and implemented regulations.[24]

The City's Comprehensive Plan currently outlines goals, policies, and actions regarding natural hazards in Beaverton, which are listed below. Chapter Seven of Beaverton's Comprehensive Plan addresses seismic, geological, and flood hazards.

**Seismic Hazards**

Goal: Protect life and property from potential earthquake hazards.

1. Policy: Limit as much as possible the potential loss of life and property resulting from earthquakes, and minimize disruption of public facilities, services, and transportation systems.
    a. Action: Prepare and adopt programs and regulations to reduce the potential impacts of earthquakes on: existing and new structures, infrastructure, and transportation systems.
2. Policy: Ensure that key public, semi-public and private building retain structural integrity and remain functional in the event of an earthquake.
    a. Action: Develop a program and seek funding to retrofit existing public buildings and consider establishing tax incentives to retrofit other semi-private, or private

structures that house essential services and are identified as high risk sites.

### Geological Hazards

Goal: Protect life and property from geological hazards associated with identified unstable steep slopes, erosion and deposition, and weak foundation soils.

1. Policy: Limit or prohibit development in geologically hazardous areas that pose a threat to life and property
   a. Action: Identify geological hazard sites in the City including unstable steep slopes, weak foundation soils, and areas subject to erosion and deposition. Adopt and apply regulations to these sites through engineering standards and site development design criteria to allow, limit, or prohibit development, as appropriate.
   b. Action: Periodically review and update the existing erosion control regulations and enforcement procedures to improve their effectiveness.
   c. Action: Adopt and apply land use regulations requiring that building sites, streets and other improvements in areas with 25% or greater slopes, be designed so that cuts and fills are minimized and best management practices for erosion control are integrated into the design.
2. Policy: The City shall support the reclamation of aggregate sites having a Department of Geology and Mining Industry (DOGAMI) mining permit, to ensure the stability of slopes and prevention of erosion, and to prevent the creation of weak foundation soils.
   a. Action: Adopt and apply appropriate site development code requirements to ensure the DOGAMI reclamation process is completed prior to the issuance of a site development permit.

### Flood Hazards

Goal: Maintain the functions and values of floodplains, to allow for the storage and conveyance of stream flows and to minimize the loss of life and property.

1. Policy: Utilize uniform or complementary inter-jurisdictional floodplain development and management programs to reduce flood hazards, protect natural resources, and permit reasonable development.
2. Development shall be prohibited in the floodway, except as necessary for the placement of roadways, utilities, stormwater conveyance, bridges, culverts, and grading related to public utility projects as permitted by the appropriate implementing ordinances.

3. Construction within the flood fringe shall be regulated through the City's implementing ordinances, such as the City's Engineering Design Manual and Standard Drawings.
4. Uncontained areas of hazardous materials, as defined by the DEQ, shall be prohibited in the floodplain.
    a. Action: Develop a program to remove hazardous obstructions and debris from floodplains.
    b. Develop a flood damage reduction program to protect, to the extent practicable, existing development in the 100-year floodplain, following guidelines and regulations established by the Federal Emergency Management Agency (FEMA). Alternatively, explore programs to encourage removal of existing development from floodplains.

The City of Beaverton Development Code outlines special requirements for utility undergrounding as well as floodplain regulations. The purposes for the utility requirements include protecting essential public services from natural and manmade accidental disruptions as well as improving public safety by reducing the possibility for injury from downed lines. Traditional overhead power lines can cause significant damage during severe weather events and undergrounding the lines has been identified as a potentially effective mitigation strategy. The floodplain regulations are designed to:

- Protect human life and health property;
- Minimize expenditure of public money, costly repairs of flood damage, and costly flood control projects;
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- Minimize prolonged business interruptions;
- Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in areas of special flood hazard;
- Help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas;
- Make information available upon request to potential buyers that property is in an area of special flood hazard;
- Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions; and
- Maintain the functions and values of floodplains, such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems.

# Housing and Community Development

Gaining an understanding of the City's current housing stock as well as trends in community development are important in planning for natural hazards because development in Beaverton has increased steadily with population growth. Each year Beaverton's Building Division issues a combined total of 4,200 to 5,000 building, mechanical, plumbing, electrical, and sewer permits. In 2002, 1,156 building permits were issued, compared with 1,127 permits issued in 2001. The number of permits issued has been steadily increasing over the last decade, and are up 10% since 1990.

According to the 2000 US Census, there are 32,507 housing units within the City. Of the total housing units, 52.3% are rental units and the remaining 47.7% are owner-occupied. The majority of homes in Beaverton were built between 1970 and 1989; new dwelling construction has been on the decline since that period. The year in which a structure is built is an important indicator of how well a structure will perform during an event. For example, in 1990 the Oregon Building Codes Division revised its construction standards for new buildings to make them more resistant to seismic events. Therefore, homes built after 1990, are likely to perform better during an earthquake or related hazard. The following table provides information on the age structure of Beaverton's housing units.

**Table 2.2: Housing Age Structure, Beaverton, 2002**

| Year | Number | Percent |
|---|---|---|
| 1999 - March 2000 | 647 | 2 |
| 1995-1998 | 3447 | 10.6 |
| 1990-1994 | 5048 | 15.5 |
| 1980-1989 | 7962 | 24.5 |
| 1970-1979 | 8413 | 25.9 |
| 1960-1969 | 4110 | 12.6 |
| 1940-1959 | 5427 | 7.6 |
| 1939 or Earlier | 423 | 1.3 |

Source: US Census 2000

Beaverton's housing market has demonstrated a fluctuating growth pattern over the past forty years. Continual production of new housing throughout the city, coupled with restrictions imposed by the Urban Ground Boundary (UGB), has resulted in a drastic slowdown in growth over the last several years. Although some of this slowdown can be attributed to market fluctuations, a significant measure can also be explained by the fact that, while the city's population has increased, the amount of land capable of absorbing the need for new housing has decreased. [25]

In recognition of the fact that Beaverton suffers from a shortage of buildable residential land, the city has begun to examine alternatives associated with housing types that emphasize increasing the density potential for new residential development. Recent policy changes designed to address these factors include the adoption of an R4 zone (allowing for a minimum lot size of 4,000 square feet per dwelling unit), the easing of restrictions associated with accessory dwelling units and manufactured housing, adoption of mixed use zones, and development of code text amendments requiring that all new development achieve a minimum density of the 80% of allowable capacity.[26]

Affordable housing has also become a topic of great concern over the past decade. The problem is largely due the fact that wage rates have not been able to keep pace with escalating housing costs. The result has been an ever-widening affordability gap that has the potential to dislocate area residents. According to Oregon's Multiple Listing Service, the average home price for the Beaverton area in 1990 was $91,633. By 1999, the average price had almost doubled at $175,700. While a segment of this increase can be attributed to escalating costs in permit fees, transportation impact fees, and system development charges, the bulk of the change comes from an increase in land value. [27]

During 2002, Beaverton's Community Development Block Grant funds supported housing rehabilitation, public facilities, planning and administration, and public services expenses. The city's Housing Rehabilitation Program is funded by two federal sources: Community Development Block Grant (CDBG) funds and Home Investment Partnerships Program (HOME) funds. [28]

# Employment and History

Beaverton's per capita income according to the 2000 Census is $25,419. Median earnings are $41,863 for full-time male workers, and $31,204 for females. According to the 2000 Census, Beaverton had 40,922 employees, accounting for one-third of all Washington County employees. Table 2.3 provides a breakdown of jobs and the number employed by industry type. [29]

### Table 2.3: Employment by Industry, Beaverton, 2000

| Industry | Number Employed |
|---|---|
| Manufacturing | 6,839 |
| Educational, Health, and Social Services | 6,458 |
| Professional, Scientific, Admin, Waste Services | 6,081 |
| Retail Trade | 4,859 |
| Finance, Insurance, Real Estate, Rental and Leasing | 3,869 |
| Arts, Entertainment, Recreation, Accommodation, Food Services | 3,358 |
| Construction | 2,099 |
| Wholesale Trade | 1,947 |
| Other Services | 1,572 |
| Transportation and Warehousing, Utilities | 1,547 |
| Information | 1,223 |
| Public Administration | 937 |
| Agriculture, Forestry, Fishing and Hunting, Mining | 133 |
| **TOTAL JOBS** | **40,922** |

Source: US Census 2000

Washington County's largest public and private employers are Intel, Tektronix, Nike, Sequent Computer Systems, and the Dynamics Research Corporation. The total number of employees working for these top five employers totaled 18,750. Approximately, 76% of Beaverton's employment are small businesses with more than 20 employees.[30]

Today, Beaverton's economy is a mix of high tech and software companies, professional and business services, and retail and wholesale trade. It supports both traditional and knowledge-based industries, as well as provides goods and services to export markets and local consumers.[31]

## Transportation and Commuting

Transportation in Beaverton includes state and County highways, arterial streets, collector streets, neighborhood routes, local streets, Tri-Met bus service, Westside Light Rail, and multiple bicycle routes. Beaverton's transportation network serves both residential and commercial commuters. A map in this plan's Map Section titled Functional Road Classification further highlights the area's transportation network.

The Tri-County Metropolitan District of Oregon (Tri-Met) provides public transportation in Beaverton. Tri-Met's service includes bus and light rail. The newly opened Westside Light Rail is aligned in an east to west direction following Highway 26 to Beaverton and continues west to the Hillsboro Government Center.

U.S. Highway 26, also known as the Sunset Highway, has the greatest traffic volume, and serves as a central connecting route between the coast and downtown Portland. Oregon Highway 217 serves to connect Highway 26 to and from Interstate 5. Highway 26 runs east to west, while Highway 217 runs north to south. Both of these highways are major traffic routes through and around Beaverton. Highway 210, also known as Scholls Ferry Road, has the next highest traffic volume. Highways 8 and 10 are major commuting routes as well, but are not as significant in overall traffic volume.

Congestion is an increasing problem for Beaverton, even with the recent expansion of the light rail system. Overall, the two-way traffic volumes in Beaverton have increased from 5 to 50 percent between 1996 and 2000.[32] However, some of the two-way traffic volumes have actually decreased over the four-year period.[33] Traffic volumes on Scholls Ferry Road have shown the greatest increase, mostly due to residential development towards the west.

Overall, commuting patterns in Beaverton are similar to the rest of the state and the nation. The majority of people traveling to work do so alone in their car. Approximately 72.5% of workers drive alone, 10.6% carpool, and 8.3% commute by public transit with an average commute time of approximately 23 minutes.[34] However, one exception is the number of workers commuting by public transit, which is well above that of the state and nation as a whole. In addition, 4.5% of the workforce works from home.[35] According to the 2000 Oregon Employment Department: Regional Economic Profile for Region 2, which includes the City of Beaverton, approximately 40% of the working population in Washington County commuted to destinations outside of the county, primarily to Multnomah County.

## Historic and Cultural Resources

The City of Beaverton has 97 identified historic resources on the Historic Resources Inventory completed in 1987, of those 33 "significant" historic resources are regulated under Statewide Planning

Goal 5. Regulated resources under Statewide Planning Goal 5 include the "Significant" and "Important" categories on Beaverton's Historic Resource Inventory. "Significant" resources are defined as: individually the important buildings, sites, structures or objects in Beaverton distinguished by outstanding qualities or architecture, relationship to environment and/or historic associations.[36] In addition to inventorying the "significant" resources, the Inventory also identifies "important", "contributing" and "unrankable" resources. "Important is defined as: buildings, sites, structures or objects, which are not of outstanding distinctiveness or variety, in terms of architecture or historic association and/or relationship to environment, but have sufficient significance to make them worthy of preservation. "Contributing" is defined as: buildings, sites, structures or objects, which are less significant examples of architecture or of lesser historical association, which may also provide the contexts for more significant resources. "Unrankable" resources are defined as: lacking sufficient information to be ranked. Additionally, the City has one historic district on the National Register of Historic Places. The City is in the process of integrating this information into a database that can be integrated into a GIS system.

## Critical Facilities and Infrastructure

Critical and essential facilities are those facilities that are vital to the continued delivery of key governmental services that may significantly impact the public's ability to recover from the emergency. During a natural disaster, it is very important to have operational facilities from which the city and recovery organizations can provide assistance. These critical facilities include 911 centers, emergency operations centers, police and fire stations, public works facilities, hospitals, bridges and roads, and shelters. Facilities that may cause secondary impacts if damaged or destroyed, such as chemical production plants, are considered critical facilities as well. Essential facilities include schools, jails, law enforcement centers, public service buildings, and the courthouse. A map in this plan's map section titled Critical Facilities highlights public and private schools, community centers, nursing homes, hospitals, and the light rail system.

## Section Endnotes

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# Chapter 3
# Risk Assessment

This Chapter provides information of the natural hazard risk assessment process. It is general in scope, providing information on what a risk assessment entails as well as listing the related hazard vulnerability maps that are included in this plan. Risk assessment information for each of the hazards identified in this plan can be found in the hazard specific chapters listed below:

- Chapter 7: Flood
- Chapter 8: Severe Weather
- Chapter 9: Landslide
- Chapter 10: Wildfire
- Chapter 11: Earthquake
- Chapter 12: Volcanic Eruption

## What is a Risk Assessment?

A risk assessment is the process for identifying threats and vulnerabilities of natural hazards for specific communities. Conducting a risk assessment can provide information on the areas where the hazards may occur, the value of existing land and property in those areas; and an analysis of the potential risk to life, property, and the environment that may result from natural hazard events. Specifically, the levels of a risk assessment per Federal Section 322 requirements are as follows:

1) ***Hazard Identification*** identifies the geographic extent of the hazard, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data. Beaverton identified six major hazards that consistently affect this geographic area. These hazards – floods, landslides, wildfires, severe weather, earthquakes, and volcanic eruption – were identified through a process that utilized input from a project steering committee as well as through the Beaverton Hazard Analysis, in the City's Emergency Response and Recovery Plan. The City's Geographic Information Systems (GIS) Service, using the best available data, has identified the geographic extent of each of the identified hazards. The Map Section of this plan contains the maps used for this plan.

2) ***Profiling Hazard Events*** describes the causes and characteristics of each hazard, how they have affected Beaverton in the past, and what part of Beaverton's population, infrastructure, and environment has historically been vulnerable to each specific

hazard. A profile of each hazard addressed in this plan is provided in each hazard specific section. For a full description of the history of hazard specific events, please see the appropriate hazard chapter.

3) ***Vulnerability Assessment/Inventorying Assets*** combines the hazard identification with an inventory of existing (or planned) property and population that would be exposed to a hazard. Critical facilities are of particular concern because they provide essential products and services that are necessary to preserve the welfare and quality of life in the City and fulfill important public safety, emergency response, and/or disaster recovery functions. The critical facilities have been identified, mapped, and are illustrated in Map Section of this plan. A description of the critical facilities in the City is also provided in this section. A community issues summary is included in each hazard section that identifies the most vulnerable and problematic areas in the City, including critical facilities and other public and private property.

4) ***Risk Analysis/Estimating Potential Losses*** involves estimating the damage, injuries, and financial losses likely to be sustained in a geographic area over a given period of time. This level of analysis typically involves using mathematical models. The two measurable components of risk analysis are magnitude of the impact that may result from the hazard event and the likelihood of the hazard occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets. Where available, the best available data was used to determine the magnitude and likelihood of future natural hazard events. For each hazard where data was available, quantitative estimates for potential losses are included in the hazard assessment.

5) ***Assessing Vulnerability/ Analyzing Development Trends*** provides a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. This plan provides comprehensive description of the character of Beaverton in Chapter 2: Community Profile. This description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, transportation and commuting patterns, and historic and cultural resources. Analyzing these components of Beaverton can help in identifying potential problem areas, and can serve as a guide for incorporating the goals and ideas contained in this mitigation plan into other community development plans.

**THREE PHASES OF HAZARD ASSESSMENT:**

Hazard Identification    Vulnerability Assessment    Risk Analysis

Hazard assessments are subject to the availability of hazard-specific data. Gathering data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard-specific section of the plan includes a section on hazard identification using data and information from city, county, and state agency sources.

Beaverton conducted a vulnerability assessment for the flood hazard using Geographic Information Systems (GIS) to identify the geographic extent of the hazard and assess the land use and value at risk from the flood hazard. At the time of publication, insufficient data existed to conduct vulnerability assessments and risk analyses for a majority of the hazards addressed in the plan.

Regardless of the data available for hazard assessments, there are numerous strategies the City can use to reduce risk. These strategies are described in the action items detailed in each hazard section of this plan. Mitigation strategies can further reduce disruption to critical services, reduce the risk to human life, and alleviate damage to personal and public property and infrastructure. Action items throughout the hazard sections provide recommendations to collect further data to map hazard locations and conduct hazard assessments.

### Federal Requirements for Risk Assessment

Recent federal requirements for hazard mitigation plans, outlined in 44 CFR Part 201, include a requirement for risk assessment. This risk assessment requirement is intended to provide information that will help communities to identify and prioritize mitigation activities that will reduce losses from the identified hazards. There are six hazards profiled in the mitigation plan, including floods, landslides, wildfires, earthquakes, severe weather, and volcanic eruptions. The Federal criteria for risk assessment and information on how the City of Beaverton Natural Hazard Mitigation Plan meets those criteria is outlined in Table 3-1 below.

## Table 3-1. Federal Criteria for Risk Assessment

| Section 322 Requirement | How is this Addressed in the Plan? |
|---|---|
| Identifying Hazards | Each hazard chapter includes a description of the best available data sources that identify hazard areas. To the extent GIS data area available, the City developed maps identifying the location of the hazard in the City. The Executive Summary and the Risk Assessment chapters of the plan include a list of the hazard vulnerability maps. |
| Profiling Hazard Events | Each hazard chapter includes documentation of the history, and causes and characteristics of the hazard in the City. |
| Assessing Vulnerability: Identifying Assets | Each hazard chapter provides information on vulnerable areas in the City in the Community Issues section. Each section also identifies potential mitigation strategies. |
| Assessing Vulnerability: Estimating Potential Losses | The Risk Assessment chapter of this Mitigation Plan identifies key critical and essential facilities in the City and includes a map of these facilities. Vulnerability assessments were completed for each hazard where data was available. |
| Assessing Vulnerability: Analyzing Development Trends | The Community Profile chapter of this plan provides a description of the development trends in the City, including geography and environment, population and demographics, land use and development, housing and community development, employment and industry, transportation and commuting patterns, and historic and cultural resources. |

# Chapter 4
# Mitigation Plan Goals, Action Items, and Public Participation

This chapter provides information on the process used to develop goals and action items addressed in the mitigation plan. It also describes the framework that focuses the plan on developing successful mitigation strategies. The framework is made up of two parts: *Goals* and *Action Items.*

### Goals

The plan *goals* describe the overall directions that Beaverton departments, organizations, and citizens can take to work toward mitigating risk from natural hazards. The goals are guiding principles for the specific recommendations that are outlined in the action items.

### Action Items

The *action items* are detailed recommendations for activities that city departments, citizens and others could engage in to reduce risk.

## Mitigation Plan Goals

The plan goals help to guide the direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals listed here serve as checkpoints as agencies and organization begin implementing mitigation action items.

Meetings with the project steering committee, stakeholder interviews, a household and business survey, as well as a focus group served as methods to obtain input and identify priorities in developing goals for reducing risk and preventing loss from natural hazards in Beaverton.

Beaverton's Natural Hazards Mitigation Plan goals are based on the goals established by Washington County in their Natural Hazards Mitigation Plan. The City's project steering committee reviewed the county's goals and made recommendations during a meeting on February 11, 2003, for adapting them to the City's needs. The following are the resulting goals for the City of Beaverton's Natural Hazards Mitigation plan.

## Goal 1: Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

1. Reduce insurance losses and repetitive claims for chronic hazard events while promoting insurance coverage for catastrophic hazards.
2. Evaluate applicable city guidelines, codes, and permitting processes regarding how they address natural hazard mitigation.
3. Link watershed planning, natural resource management, and land use planning with natural hazard mitigation activities to protect vital habitat and water quality.
4. Preserve and rehabilitate natural systems to serve natural hazard mitigation functions.
5. Continuously develop and update natural hazard related datasets.

## Goal 2: Improve Partnerships for Communication and Coordination

1. Develop and implement natural hazard education and outreach programs to increase awareness among citizens; local, city, and regional agencies; non-profit organizations; and businesses.
2. Strengthen communication, coordination and collaboration among public agencies, citizens, non-profit organizations, and businesses working in natural hazard risk reduction.

## Goal 3: Enhance Emergency Services

1. Strengthen emergency operations by increasing communication, collaboration and coordination among public agencies, non-profit organization, and businesses.
2. Coordinate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

## Goal 4: Ensure Implementation of Mitigation Activities

1. To implement natural hazard mitigation activities, develop and continue partnerships and promote leadership within local and regional public agencies; citizens; non-profit organizations; and businesses.
2. Ensure consistency between city, county, regional, and state mitigation activities.
3. Consistently, seek diverse funding and resource partnerships for future mitigation efforts.

# Mitigation Plan Action Items

The mitigation plan identifies short and long-term action items developed through data collection and research, along with the public participation process. Mitigation plan activities may be considered for funding through state and federal grant programs, including the Federal Emergency Management Agency's Hazard Mitigation Grant Program and Pre-Disaster Mitigation Competitive Grant Program, as funds are made available. Action items address both multi-hazard (MH) and hazard specific issues for the hazards addressed in this plan. To facilitate implementation, each action item includes information on timeline, coordinating and partner organizations, ideas for implementation, and plan goals addressed.

**Coordinating Organization**. The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. The coordinating organization for all action items within the Beaverton plan will be the City of Beaverton.

**Internal Partners:** Internal partner organizations are departments within the City that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

**External Partners:** External partner organizations can assist the City in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

*The internal and external partner organizations listed in the Mitigation Plan are potential partners recommended by the project steering committee, but not necessarily contacted during the development of the plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial contact is also to gain a commitment of time and or resources towards completion of the action items.*

**Timeline.** Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that city departments may implement with existing resources and authorities within one to two years. *Long-term action items* (LT) may require new or additional resources and/or authorities, and may take between one and five years to implement.

**Ideas for Implementation.** Each action item includes ideas for implementation and potential resources. This information offers a transition from theory to practice. The ideas for implementation serve as a starting point for this plan. This component of the action items is dynamic as some ideas may be not feasible and new ideas can be added during the plan maintenance process. (For more information on how this plan will be implemented and evaluated, see Chapter 5). These action items are suggestions for ways to implement the plan goal only. Some of these items may prove to be unrealistic and others more refined ideas may be identified and added to the plan. Ideas for implementation include things such as collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure. A list of potential resources outlines what organization or agency will be most qualified and capable to perform the implementation strategy. Potential resources often include utility companies, non-profits, schools, and other community organizations.

**Plan Goals Addressed.** The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals following implementation.

# Public Participation

Public participation during the development of the mitigation plan assisted in creating plan goals. Focus groups held on April 16 and 21, 2003 resulted in public ranking of generic plan goals as well as implementation strategies. Appendix D contains the full results of the focus group process including the prioritization of general plan goals and implementation strategies. The fourteen participants that took part in the focus groups were individual citizens. This public process generated ideas for action items. Participants emphasized the importance of education and outreach as well as working with existing organizations within the community.

# Chapter 5
# Plan Implementation and Maintenance

The plan maintenance chapter of this document details the formal process that will ensure that the City of Beaverton Natural Hazards Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing an updated plan every five years. This chapter also describes how the City will integrate public participation throughout the plan maintenance process. Finally, this chapter includes an explanation of how the City intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City comprehensive land use plan, capital improvement plans, and building codes.

The plan's format allows the City to review and update sections when new data becomes available. The ability to update individual sections of the mitigation plan places less of a financial burden on the City. New data can be easily incorporated, resulting in a natural hazards mitigation plan that remains current and relevant to the City of Beaverton.

## Implementing the Plan

The effectiveness of the non-regulatory City of Beaverton Natural Hazard Mitigation Plan will be contingent on the implementation of the plan and incorporation of the outlined action items into existing plans. After the plan is formally adopted, a coordinating body will be assigned, a convener shall be designated, the identified activities and their prioritization will be validated by the coordinating body, and finally, the activities will be implemented, as resources permit, through existing plans, programs, and policies.

Once the plan has been adopted, the City Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer at Oregon Emergency Management. Oregon Emergency Management will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Beaverton will gain eligibility for Hazard Mitigation Grant Program funds.

### Coordinating Body

The Hazard Mitigation Steering Committee will serve as the coordinating body for the plan and will be responsible both for coordinating the implementation of plan action items and for undertaking the formal review process. The Mayor's Office will ensure that appropriate representatives are assigned from the applicable city departments and programs, including, but not limited to, the current Hazard Mitigation Steering Committee members. The City originally formed the Hazard Mitigation Steering Committee to assist in the development of the plan and currently consists of members from local agencies, organizations, and citizens, and including:

- City of Beaverton Emergency Management Program
- City of Beaverton Community Development Department/Planning Services
- City of Beaverton Engineering Department
- City of Beaverton Community Development Department/Building Division
- City of Beaverton ISD/GIS Service
- City of Beaverton Operations and Maintenance Department
- City of Beaverton Mayor's Office/Neighborhood Program
- Office of Consolidated Emergency Management (OCEM)
- Portland General Electric (PGE)
- American Red Cross (ARC)
- Beaverton Chamber of Commerce
- Oregon Emergency Management (OEM)

To make this committee as broad and useful as possible, the committee is encouraged to engage other relevant organizations and agencies in hazard mitigation. The recommendations for adding to the Hazard Mitigation Steering Committee include:

- An insurance representative
- Representation from a professional organizations such as Home Builders
- Representation from the Committee for Citizen Involvement (CCI)

The Hazard Mitigation Steering Committee will have no less than quarterly meetings, which will be scheduled once the final Hazard Mitigation Steering Committee has been established. These meetings will provide an opportunity to discuss the progress of the action items in the plan, and maintain the partnerships that are essential for the sustainability of the Mitigation Plan.

## Convener

Although the City Council will provide ownership of the City of Beaverton Natural Hazard Mitigation Plan, the City's Emergency Manager will take responsibility for plan implementation. The Emergency Manager will facilitate the Hazard Mitigation Steering

Committee meetings and will assign tasks such as updating and presenting the plan to the rest of the members of the committee. Plan implementation and evaluation will be a shared responsibility among all of the assigned Hazard Steering Committee Members.

## Implementation through Existing Programs

The City of Beaverton currently addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvement plans, and City building codes. The Natural Hazard Mitigation Plan is non-regulatory in nature and provides a series of recommendations – many of which are closely related to the goals and objectives of these existing planning programs. To the extent possible, the City of Beaverton should incorporate the recommended mitigation action items into existing programs and procedures. These goals and action items will help the City of Beaverton address statewide land-use planning Goal 7 which was developed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards. Goal 7 requires that local governments base development plans on inventories of known areas of natural disasters and hazards and that the intensity of development should be limited by the degree to which the natural hazard occurs within the areas of proposed development. The City can use review of this plan as an avenue to update the Goal 7: Natural Hazards element of their comprehensive plan and to integrate mitigation into zoning and planning documents.

The City Building Division is responsible for administering the building codes in Beaverton. After the adoption of the mitigation plan, they will work with the State Building Code Office to make sure that the City adopts, and is enforcing, the minimum standards established in the new State Building Code. In addition, the Hazard Steering Committee will promote safe building practices in an effort to have structures more resistant from the impacts of all hazards.

Capital improvement planning that occurs in the future will also contribute to the goals in the Hazard Mitigation Plan. Various City Departments develop Capital Improvement Programs (CIPs), and review them on an annual basis. The Hazard Mitigation Steering Committee will work with these departments to identify action items from Natural Hazard Mitigation into appropriate sections of the CIPs.

Within six months of formal adoption of the Mitigation Plan, the policies listed above will be incorporated into the process of existing planning mechanisms at the City level. The meetings of the Hazard Mitigation Steering Committee will provide an opportunity for committee members to report back on the progress made on the integration of mitigation planning elements into City planning documents and procedures.

### Economic Analysis of Mitigation Projects

FEMA's methods of identifying the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

The Hazard Mitigation Steering Committee will use FEMA-approved cost benefit methodology as a tool for identifying and prioritizing mitigation action items when applying for federal mitigation funding. For other projects and funding sources, the Hazard Mitigation Steering Committee will use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix E of the Plan.

### Methodology for Prioritizing Plan Action Items

To initially prioritize the plan's action items the City of Beaverton utilized a multi-tiered approach. First the plan goals were prioritized. Second, the natural hazards identified in the community were prioritized based on the hazard risk assessments used in the City of Beaverton's Business Continuity Plan (BCP). Using the outcome of these two activities each action item was tallied according to a point system in a third step in order to determine its relative priority within the plan. The prioritized list of action items serves simply as a starting point for the implementation of mitigation activities. The information presented on the economic analysis of mitigation activities (Appendix E) also is an integral aspect in determining action item priorities.

The Hazard Mitigation Steering Committee and the leadership of the City of Beaverton have the option to implement any of the action items at any time. This allows the committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of highest priority. The methodology used to initially prioritize the plan's action items (See Chapter 1) will also be used by the Hazard Mitigation Steering Committee to maintain the list.

## Evaluating and Updating the Plan

### Formal Review Process

The City of Beaverton has developed a method to ensure that a regular review and update of the Hazard Mitigation Plan occurs. All Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan and the Emergency Manager is responsible for contacting the Committee members and organizing a plan review meeting at least annually.

The committee will review each goal and objective to determine their relevance to changing situations in the City, as well as changes in State or Federal policy, and to ensure they are addressing current and expected conditions. The committee will also review the risk assessment portion of the Plan to determine if this information should be updated or modified. The designated parties responsible for the various implementation actions will report on the status of their projects and will include which implementation process worked well, any difficulties encountered, how coordination efforts were proceeding, and which strategies should be revised.

The Emergency Management Program will be responsible for incorporating the changes and updates to the plan before submitting the final document to the Hazard Steering Committee members, and presenting it to the City Council for approval. The updated Plan will then be submitted to the State Hazard Mitigation Officer for review. If no changes are necessary, the State Hazard Mitigation Officer will be given a justification for this determination.

## Continued Public Involvement

The City of Beaverton is dedicated to involving the public directly in the continual reshaping and updating of the Hazard Mitigation Plan. Although members of the Steering Committee represent the public to some extent, the public will have the opportunity to provide feedback about the Plan.

Copies of the Plan will be catalogued and kept at the City of Beaverton public library. The existence and location of these copies will be publicized in the newsletter "Your City". The Plan includes the address and the phone number of the Emergency Management Program Office, responsible for keeping track of public comments on the Plan.

In addition, copies of the plan and any proposed changes may be posted on the City website. This site will also contain an email address and phone number to which people can direct their comments and concerns.

A public meeting will also be held after each annual evaluation or when deemed necessary by the Hazard Mitigation Steering Committee. The meetings will provide the public a forum for which they can express their concerns, opinions, or ideas about the Plan. The Mayor's Office will maintain public involvement and advertise for the public meetings through existing community organizations such as the Neighborhood Association Committees. The City Emergency Manager will be responsible for using City resources to publicize the annual public meetings and maintain public involvement, which may include the public cable access channel (TVTV), city webpage, and local newspapers.

## Chapter 6

# Multi-Hazard Action Items (MH)

This chapter describes at hazard impacts and mitigation measures that are not hazard dependent. There are several potential impacts that are common among more than one of the six hazards covered in this plan, as well as other hazards not addressed (i.e., structural damage can be caused by earthquake, high-winds, or landslides). Conversely, there are mitigation measures and potential action items that are applicable to more than one hazard. Implementation of multi-hazard mitigation measures will increase a community's hazard resilience regardless of which hazard might strike.

## What is the threat to Beaverton?

While remote, the potential exists that the city could experience the impacts of two different natural hazards at the same time. Additionally several of the natural hazards that may occur will have the same or similar impacts on property, infrastructure, and lives. Addressing these multi-hazards items together rather than by hazard offers a more practical, coordinated, and cost effective approach than trying to address them within each hazard

## Multi-Hazard Assessment

Since the multi-hazard items relate to multiple hazards, the established methodology for identifying the hazard, vulnerability, and risk of the specific hazards is not applicable. The primary assessment criteria is that the actions address more than one of the natural hazards covered in this plan.

### Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature; guidance from the Beaverton Natural Hazards Mitigation Steering Committee; and interviews with both Beaverton and Washington County stakeholders. Goals for this mitigation plan address four categories:

1. Protect human life, commerce, property, and natural systems
2. Improve Partnerships for Communication and Coordination
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

## Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, federal agencies, utilities or other organizations.

## City Programs

### Capital Improvement Plan

The City of Beaverton's Capital Improvements Plan (CIP) is a dynamic document that lists and prioritizes needed improvements and expansions of the City's infrastructure system to maintain adequate service levels to existing City residents and businesses, and to accommodate population growth and land development. The CIP reflects the needs and priorities established by the City and the resources available to the City. The CIP can be modified during the fiscal year, through the supplemental budget process, as needs, priorities, and resources change. The CIP can assist the City of Beaverton in mitigating against severe weather events by improving infrastructure most prone to damage.

### Emergency Operation Center (EOC)

The Emergency Operations Center is an established location/facility from which City staff and officials can provide direction, coordination, and support to emergency operations in the event of an incident such as a natural disaster. City personnel who are assigned to and trained for specific positions within the EOC organizational structure staff the EOC. The structure is based on the National Interagency Incident Management (NIIMS) Incident Command System (ICS). The EOC staff provides information and recommendations to the Mayor, through the Incident Commander or as directed, to develop a course of action to respond to and contain, control, and recover from an emergency. Some of the primary functions performed at the EOC include: coordination, operations management, planning, information tracking and dissemination, logistical support, financial management and support, and emergency public information.[1]

### Emergency Response and Recovery Plan (ERRP)

The Emergency Response and Recovery Plan (ERRP) describes the roles and responsibilities of the departments and personnel for the City of Beaverton during major emergencies or disasters.

The Plan sets forth a strategy and operating guidelines using NIIMS ICS which was adopted by the City for managing its response and recovery activities during disasters and emergencies.

The ERRP consists of various sections and supporting materials. The development and maintenance of this plan is the basis of the City's emergency response and recovery operations.

1. **Basic Plan** - Provides an overview of the City's emergency response organization and policies. It cites the legal authority for emergency operations, summarizes the situations addressed by the plan, explains the general concept of operations, and assigns general responsibilities for emergency planning and operations.
2. **Functional Annexes** - Each annex focuses on one of the critical emergency functions that are typically common for all hazards, which the City will perform in response to an emergency. The type and scope of an incident will dictate which functional annexes will be needed.
3. **Hazard Specific Appendices** - The appendices provide additional detailed information and special considerations that are applicable to specific hazards. The appendices are to be used in conjunction with the Basic Plan and the Functional Annexes.[2]

### Incident Command System

The Incident Command System (ICS) is a management system that may be used for any time of hazard event, and has three main components:

**Command** - A designated lead person responsible for:

- Assessing the situation and resources
- Developing and implementing an appropriate action plan
- Monitoring the effectiveness of the plan
- Reviewing/modifying the plan as changes occur

**Resource Control** - Resources must be properly directed to maximize their utilization.

**Communication** - In order to orchestrate and coordinate the use of resources at an incident, all members of the incident response team must be linked by:

- A well-defined organizational structure
- Clear lines of communication

### Transportation Plan

The City of Beaverton's adopted transportation plan is the Transportation Element of the City's Comprehensive Plan. It identifies the transportation improvements needed to accommodate existing and future development in the Beaverton area. The plan projects needs and improvements through 2015.

Beaverton's adopted transportation plan is based on an analysis contained in the Transportation System Plan (TSP), which was developed through a public participation process. The development of the TSP and thereafter the more concise Transportation Element, along with Chapter Six of the Comprehensive Plan, (a summary of the analysis, goals and policies, and improvements) are closely coordinated and intended to be consistent with other jurisdictions' transportation plans. These include Washington County's Transportation Plan, Metro's Regional Transportation Plan and Urban Growth Management Framework Plan, TriMet's short and long-range transit plans, and the State of Oregon Transportation Plan. Coordination with these and other jurisdictions and service agencies is continuous.

## Multi-Hazard Mitigation Action Items

Multi-hazard action items are those activities that cut across all six hazards in the mitigation plan: flood, severe weather, wildfire, landslide, earthquake and volcanic eruption.

There are five short-term and four long-term multi-hazard action items described below. Each action items is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursing strategies for implementation.

**ST-MH#1: Establish a Beaverton Natural Hazards Mitigation Committee to facilitate implementation, monitoring, and evaluation of citywide mitigation activities.**

***Ideas for Implementation:***

a. Assign appropriate representative City staff members to serve on the committee;

b. Gather group of interested and invested representatives from the business community, the non-profit sector, and the public for involvement in the committee (preferably many of the same involved with the creation of the plan);

c. Establish clear roles for participants and meet regularly to pursue and evaluate implementation of mitigation strategies;

d. Oversee implementation of the mitigation plan;

e. Facilitate the development or update of mitigation activity priorities that are consistent with the goals and framework of the *Beaverton Natural Hazards Mitigation Plan;* and

f. Work with county government and other agencies to develop strategies for implementation of plan activities.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners:** | Emergency Management, Mayor’s Office |
| **External Partners**: | Washington County, Cooperating Public Agencies of Washington County |
| **Timeline**: | 3 months |
| **Plan Goals Addressed**: | Improve Partnerships for Communication and Coordination, Ensure Implementation of Mitigation Activities |

**ST-MH#2: Identify and pursue funding opportunities to develop and implement local mitigation activities.**

***Ideas for Implementation:***

a. Allocate City resources and assistance to mitigation projects when possible;

b. Explore mitigation-related funding sources (such as FEMA Pre-Disaster Mitigation Competitive Grant Program);

c. Explore non-mitigation related funding sources (such as Green space bond measure and Community Development Block Grants and others);

d. Develop incentives for local organizations (such as Neighborhood Associations and Neighborhood Action Committees), citizens, and businesses to pursue hazard mitigation efforts;

e. Partner with other organizations and agencies in Washington County to identify grant programs and foundations that may support mitigation activities and together seek funding for mitigation projects.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners:** | Emergency Management, Economic Development |
| **External Partners**: | Clean Water Services, Westside Economic Alliance, Tualatin River Watershed Council, Washington County, Cooperating Public Agencies of Washington County, US Department of Housing and Urban Development, FEMA |
| **Timeline**: | Ongoing |
| **Plan Goals Addressed**: | Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and Coordination; Disaster Resistant and Resilient Communities |

**ST-MH#3: Develop public and private partnerships to foster natural hazard program coordination and collaboration within the Beaverton Urban Service Boundary.**

***Ideas for Implementation:***

a. Identify and develop partnerships with organizations (public and private) that have programs or interests in natural hazards mitigation to implement specific mitigation projects;

b. Establish neighborhood emergency service and mitigation volunteer teams to collaborate with Beaverton Emergency Management;

c. Develop formal collaborations with businesses in the City;

d. Develop cross-jurisdictional agreements to ensure regional implementation of mitigation activities;

e. Create a database of key contacts for each sector, including the public, private, and non-profit sectors; and

f. Identify and establish incentives for people to participate in mitigation activities.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners:** | Emergency Management, Community Development, Economic Development, Neighborhood Program |
| **External Partners:** | Utility providers, School District, Chamber of Commerce, Community Organizations, Washington County, Clean Water Services, Cooperating Public Agencies of Washington County |
| **Timeline**: | Ongoing |
| **Plan Goals Addressed**: | Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and Coordination, Disaster Resistant and Resilient Communities |

**ST-MH#4: Encourage households and businesses in Beaverton to consider natural hazard related insurance.**

***Ideas for Implementation:***

a. Educate businesses and homeowners on the availability and types of insurance related to natural hazards; and

b. Partner with insurance companies to promote natural hazard related insurance.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners**: | Emergency Management, Economic Development, |
| **External Partners**: | Insurance Providers, Chamber of Commerce |
| **Timeline**: | 1-2 years |
| **Plan Goals Addressed:** | Create a Disaster Resistant and Resilient Communities, Improve Partnerships for Communication and Coordination. |

**ST-MH#5: Strengthen emergency services by updating the City Emergency Operations Plan, linking emergency services with natural hazard mitigation programs, and enhancing public education.**

***Ideas for Implementation:***

a. Update the Emergency Operations Plan to reflect hazard-specific and demographic information within the city on a regular basis;

b. Inform the public of natural hazard response and mitigation strategies;

c. Update the natural hazard risk information and data as it becomes available; and

d. Present strategies for implementation of this action item to residents, businesses and other community organizations.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners:** | Emergency Management, Disaster Preparedness Team, GIS |
| **External Partners**: | Washington County, Tualatin Valley Fire and Rescue |
| **Timeline**: | 1-2 years |
| **Plan Goals Addressed**: | Enhance Emergency Services; Create a Disaster Resistant and Resilient Community; Improve Partnerships for Communication and Coordination. |

**LT-MH#1: Increase technical knowledge of natural hazards and mitigation strategies in Beaverton and implement policies and program based on that knowledge.**

***Ideas for Implementation:***

a. Maintain and update hazard vulnerability maps;

b. Create and maintain a GIS inventory maps of historic hazard events that documents: location, impacts, loss, etc;

c. Maintain a GIS inventory including, but not limited to: critical and essential facilities, large employers, building stock, public assembly areas and essential facilities;

d. Utilize spatial analysis tools to evaluate the City's vulnerability; and

e. Create and maintain a list of current buildings.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners**: | GIS, Operations, Emergency Management, Community Development Department |
| **External Partners**: | Washington County, DOGAMI, DLCD, OSFM, ODF, OEM, Utilities, ODOT, METRO |
| **Timeline**: | Ongoing |
| **Plan Goals Addressed**: | Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and Coordination; Create a Disaster Resistant and Resilient Communities |

**LT-MH#2: Implement appropriate mitigation measures at development sites prior to approval.**

***Ideas for Implementation:***

a. Evaluate state and local codes and regulations and explore additional code requirements regarding development in hazardous areas;

b. Ensure that all appropriate building codes and construction measures are implemented for all significant improvements to new and existing buildings;

c. Utilize vulnerability hazard maps to implement appropriate review of approved development plan; and

d. Inspect to ensure compliance with approved development plans

**Coordinating Organization**: City of Beaverton
**Internal Partners**: GIS, Community Development, Emergency Management, Neighborhood Program
**External Partners**: BCD, State Building Code Division
**Timeline**: Ongoing
**Plan Goals Addressed**: Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and Coordination; Create a Disaster Resistant and Resilient Communities

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**LT-MH#3: Create and maintain a system to support populations with special needs within Beaverton's city limits.**

***Ideas for Implementation:***

a. Create and maintain a GIS inventory of special needs populations;

b. Maintain and update preparedness information aimed at vulnerable populations;

c. Create a neighbor-to-neighbor network of voluntary organizations that will assist senior, disabled persons, and non-English speakers during disasters; and

d. Identify and create an information database on the location of centers with major concentrations of seniors, persons with disabilities (e.g., senior housing facilities and assisted living centers), minorities, and low-income residents, and develop strategies for notification and support of their evacuation;

**Coordinating Organization**: City of Beaverton
**Internal Partners**: GIS, Community Development, Emergency Management, Neighborhood Program
**External Partners**: DHS, OEM, FEMA
**Timeline**: Ongoing

**Plan Goals Addressed**: Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and Coordination; Create a Disaster Resistant and Resilient Communities

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**LT-MH#4: Improve public awareness and provide potential steps to reduce natural hazard risk.**

***Ideas for Implementation:***

a. Maintain and update preparedness information on City's website regularly and make City residents, businesses, and City staff aware of the site;

b. Develop partnerships with local print and broadcast media to foster preparedness information dissemination through television news, mail, and/or fact sheets or brochures;

c. Identify and partner with institutions and programs that can assist in providing natural hazard education and awareness to the public;

d. Encourage schools to utilize existing curriculum for school programs in schools;

e. Develop alternate-language education materials on natural hazard preparedness including audiotape and Braille;

f. Develop and maintain an ongoing program for involving citizens in future mitigation planning and activities;

g. Create and maintain a contact list for preparedness and mitigation information;

h. Develop and distribute preparedness and risk reduction information for homeowners and businesses;

i. Increase resident and business awareness of laws governing natural hazards;

j. Formally recognize citizens and businesses that are engaged in reducing the risk from natural hazards within the community;

k. Identify and partner with community organizations to provide preparedness and mitigation information to households; and

l. Invite the public to participate in annual natural hazard disaster drills.

m. Target vulnerable populations for education.

**Coordinating Organization**: City of Beaverton
**Internal Partners**: Neighborhood Program, Emergency Management
**External Partners**: OEM, FEMA, School Districts, Fire Department, DOGAMI, IBHS, Insurance Industry
**Timeline**: Ongoing
**Plan Goals Addressed:** Ensure Implementation of Mitigation Activities; Improve Partnerships for Communication and

Coordination; Create a Disaster Resistant and Resilient Communities

# Multi-Hazard Resource Directory

## City Resources

### Emergency Management Program

The City has an Emergency Manager who is part of the Mayor's Office and who is responsible for managing the City's program in all four phases of Emergency Management. Responsibilities of the City's Emergency Manager includes:

- Development and maintenance of the City's response, recovery, preparedness, and mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies [3]

**Contact:** Emergency Manager, Emergency Management
**Address:** 20665 SW Blanton Street in Aloha
**Phone**: (503) 642-0383
**Website**: http://www.ci.beaverton.or.us/departments/emergency/
**Email:** mmumaw@ci.beaverton.or.us

### Community Development Department

The Community Development Department consists of the Administration, Building, Development Services and Planning Services Divisions. The functions of the department include community planning; administration of the Community Development Code as it relates to land development; building plan review and inspections; and customer service.[4]

**Contact:** Director, Community Development Department
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2493
**Website**: http://www.ci.beaverton.or.us/departments/cdd
**Email:** cddmail@ci.beaverton.or.us

### Engineering Department

The City of Beaverton Engineering Department provides engineering and construction support to capital improvement projects and modifications to the city's infrastructure.

**Contact:** Engineering Director
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2269

**Website:** http://www.ci.beaverton.or.us/departments/engineering
**Email:** engmail@ci.beaverton.or.us

### Neighborhood Program

The Neighborhood Program offers many ways to become involved in and learn more about the city and the community. The Neighborhood Program is also responsible for supporting and assisting the Neighborhood Association Committees as well as the Committee for Citizen Involvement. The Neighborhood Program promotes citizen involvement in city government by:

- Providing support and assistance to the Neighborhood Association Committees (NACs) and Beaverton Committee for Citizen Involvement (BCCI),
- Coordinating recruitment for the City's 14 boards and commissions,
- Developing and sponsoring education and fun events; and activities for the public,
- Managing the public's use of the Beaverton Community Center

**Contact:** Program Manager, Neighborhood Program
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2243
**Website:** http://www.ci.beaverton.or.us/departments/neighborhoods
**Email:** neighbormail@ci.beaverton.or.us

### Operations and Maintenance Department

The City of Beaverton's Operations and Maintenance Department is responsible for maintaining the integrity of the city's infrastructure, including roadways, storm drainage, water quality facilities, and landscapes.

**Contact:** Operations and Maintenance Director

**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2220
**Website:** http://www.ci.beaverton.or.us/departments/
**Email:** opsmail@ci.Beaverton.us.or

### Finance Department

The Information Systems Department is part of the Finance Department and includes GIS Services.

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

## County Resources

### Metropolitan Regional Government

Metro's primary mission is to manage growth in Clackamas, Multnomah, and Washington counties and the 24 cities in the Portland, Oregon, metropolitan area. Its current role in regional land-use planning and growth management is an outgrowth of its role in establishing the urban growth boundary, transportation planning and data management.

**Address:** 600NE Grand Ave
**Phone:** (503) 797-1839
**Website:** http://www.metro-region.org

### Washington County Building Services Division

Issues permits and enforces building codes. Works on countywide coordination among city building code officials to improve the effectiveness of building inspection during an unscheduled event.

**Address:** 155 N. 1st Ave., Suite 350-12, Hillsboro, OR 97124
**Phone:** (503) 846-3470
**Website:** http://www.co.washington.or.us

### Washington County Department of Land Use and Transportation

Washington County Land Use and Transportation Department plans, builds and maintains the County's transportation systems and prepares, implements, and enforces land use plans, policies, and related State and County mandates.

**Address:** 155 N. 1st Ave., Suite 350-12, Hillsboro, OR 97124
**Phone:** (503) 846-3470
**Website:** http://www.co.washington.or.us

### Office of Consolidated Emergency Management (OCEM)

The Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county's sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff.

**Address:** 20665 S.W. Blanton St., Aloha, OR 97007
**Phone:** (503) 642-0371
**Website:** http://www.co.washington.or.us
**Email:** info@ocem.org

## Regional Resources

### Regional Emergency Management Group (REMG)

The City of Beaverton is an active member of the Regional Emergency Management Group (REMG). The REMG was formed in 1993 through an Intergovernmental Agreement between agencies in the five-county, bi-state Portland/Vancouver metropolitan area. The purpose of REMG is to:

- Recommend policy and procedures on regional emergency management issues;
- Develop an ongoing, inter-jurisdictional training and exercise program;
- Establish mutual aid agreements to ensure effective management of resources during an emergency; and
- Develop a regional emergency management plan.

The REMG has evolved from an informal regional planning group made up of emergency managers to a more formal network of public and private organizations that spans all five counties and both states.

The REMG is comprised of two committees - a technical committee (REMTEC) that is comprised of emergency management professionals and a policy advisory committee (REMPAC) that includes an elected official from each of the signatory agencies. Over the years since its inception, REMG participation has grown to include representatives from many regional utility providers and a number of local businesses

**Contact:** See Emergency Management Program

## State Resources

### Oregon State Police (OSP)–Office of Emergency Management (OEM)

OEM Coordinates a variety of statewide programs including, but not limited to:

- OEM coordinates the initial response to an earthquake, including on-site inspectors providing damage assessment. OEM also holds a statewide emergency response exercise pertaining to a possible Cascadia subduction zone earthquake;
- OEM administers FEMA's Hazard Mitigation Grant Program, which provides monies for acquisition, elevation, relocation, and demolition of structures located in the floodplain. OEM also administers FEMA's Flood Mitigation Assistance Program as well as implements and manages federal disaster recovery programs;
- In relation to Senate Bill 12 and rapidly moving landslide hazards, OEM coordinates state resources for rapid and effective response to landslide-related emergencies. It also works with other state agencies to develop information for local governments and the public on landslide hazards; and
- The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing, and providing for the prevention,

mitigation, and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the state of Oregon.

**Contact:** Hazard Mitigation Officer
**Address:** 3225 State Street, Salem, Oregon 97301
**Phone:** (503) 378-2911, ext 22247
**Website:** http://www.osp.state.or.us/oem

### Department of Land Conservation and Development (DLCD)

DLCD administers the State's Land Use Planning Program. DLCD serves as Oregon's federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities.

**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Website:** http://www.lcd.state.or.us/hazards.html

### Nature of the Northwest Information Center (NNIC)

The Nature of the Northwest Information Center is operated jointly by DOGAMI and the USDA Forest Service. It offers a selection of maps and publications from state, federal, and private agencies.

**Address:** NNIC, 800 NE Oregon St. #5, Suite 177, Portland, OR 97232
**Phone:** (503) 872-2750
**Website:** http://www.naturenw.org
**Email:** Nature.of.Northwest@state.or.us

### Oregon Climate Service (OCS)

The Oregon Climate Service collects, manages, and maintains Oregon weather and climate data. OCS provides weather and climate information to those within and outside the state of Oregon and educates the citizens of Oregon on current and emerging climate issues. OCS also performs independent research related to weather and climate issues.

**Address:** OCS, Oregon State University, Strand Ag Hall Room 316, Corvallis, OR 97331
**Phone:** (541) 737-5705
**Website:** www.cbs.state.or.us/external/bcd

### Oregon Department of Consumer and Business Services

The Building Codes Division of Oregon's Department of Consumer and Business Services is responsible for administering statewide building codes. Its responsibilities include adoption of statewide construction standards that help create disaster-resistant buildings, particularly for flood, wildfire, wind, foundation stability, and seismic hazards. Information about wildfire related building codes is found through this department.

**Address:** 1535 Edgewater St. NW, P.O. Box 14470, Salem, OR 97309
**Phone:** (503) 373-4133

**Website:** www.cbs.state.or.us/external/bcd

# Federal Resources

## Bureau of Indian Affairs (BIA)

Project grants and technical assistance to substantially eliminate sub-standard Indian Housing

**Address:** Division of Housing Assistance, Office of Tribal Services
**Phone:** (202) 208-5427

## Department of Commerce (DOC), Economic Development Administration (EDA)

DOC and EDA are involved with:

- Disaster Mitigation Planning - Technical and planning assistance grants for capacity building and mitigation project activities focusing on creating disaster resistant jobs and workplaces; and
- Post-Disaster Economic Recovery Grants - Grant funding to assist with the long-term economic recovery of communities, industries, and firms adversely impacted by disasters.

**Contact:** EDA Disaster Recovery Coordinator
**Phone:** (800) 345-1222
**Website:** http://www.doc.gov/eda

## Department of Housing and Urban Development (HUD)

HUD is involved with the following grant programs:

- Disaster Recovery Initiative - Grants to fund gaps in available recovery assistance after disasters (including mitigation);
- Public Housing Modernization Reserve - Funding to public housing agencies for modernization needs resulting from natural disasters (including elevation, floodproofing, and retrofit;
- HOME Investments Partnerships Program - Grants to States, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons; and
- Community Development Block Grant - Grants to entitled cities and urban counties (e.g. housing, a suitable living environment, expanded economic opportunities) in non-entitled areas, for low-income and moderate-income persons. Also contact, Oregon Economic and Community Development Department.

**Contact:** Community Planning and Development, Grant Programs, Office of Affordable Housing
**Phone:** (800) 998-9999

## Federal Emergency Management Agency (FEMA)

FEMA is involved with the following programs:

- Emergency Management/Mitigation Training – Training in disaster mitigation, preparedness, planning;
- Hazard Mitigation Grant Program - Grants to states and communities for implementing long-term hazard mitigation measures following a major disaster declaration; and
- Public Assistance Program - Grants to states and communities to repair damaged infrastructure and public facilities and help restore government or government-related services. Mitigation funding is available for work related to damaged components of the eligible building or structure.

**Address: Region X – 130 228th St. SW, Southwest Bothell, WA 98021**
**Website:** www.fema.gov

### Fish and Wildlife Services (FWS)

Acquires or purchases easements on high-quality lands and waters for inclusion into the National Wildlife Refuge System

**Contact: Division of Realty, National Coordinator**
**Address: Region X – 130 228th St. SW, Southwest Bothell, WA 98021**
**Phone:** (703) 358-1713

### National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

**Contact: Division of Realty, National Coordinator**
**Address: 5241 NE 122nd Avenue, Portland, OR 97230-1089**
**Phone:** (503) 326-2340
**Website:** www.noaa.gov/
**E-Mail**: answers@noaa.gov

### National Parks Service (NPS)

Identifies, assesses, and transfers available Federal real property for acquisition for state and local parks and recreation, such as open space.

**Contact:** Federal Lands to Parks Leader, National Parks Office
**Phone:** (202) 565-1184

### Small Business Administration

Provide for three types of disaster loans: Home disaster loans, Business physical disaster loans, Economic Injury Disaster Loans (EIDL) Eligibility: Home or business owners who qualify. Home loan up to $2000,000, Business loans up to $1,500,000 and EIDL up to $1,500,000.

**Address:** PO Box 13795 Sacramento, CA 95853-4795
**Phone:** (916) 566-7258

### The National Weather Service (NWS)

NWS provides weather, hydrologic, and climate forecasts and warnings for the US, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

**Address:** NWS, 5241 NE 122nd Ave., Portland, OR 97230
**Phone:** (503) 326-2340
**Website:** http://nimbo.wrh.noaa.gov/Portland

### US Department of Agriculture (USDA) - Farm Service Agency (FSA)

USDA's Farm Service Agency is involved with:

- Transfering title of certain inventory farm properties owned by FSA to federal and state agencies for conservation purposes (including the restoration of wetlands and floodplain areas to reduce future flood potential.); and
- Intent to reduce the debt of delinquent borrowers in exchange for conservation easements placed on environmentally sensitive real property. Easement secures FSA loans; and
- Intent to assist counties where physical damage or loss substantially affected farming, ranching, or agriculture. Eligibility: Farmers, ranchers, and agriculture operators.

**Address:** Farm Loan Programs, PO Box 1300 Tualatin, OR
**Phone:** (202) 720-3467

### US Forest Service

Rural development projects. Eligibility to communities.

**Address:** Pacific Northwest Region, PO Box 3623, Portland, OR 97208
**Phone:** (503) 326-6212

### USDA – Rural Development

USDA's Rural Development Division is involved with:

- Providing technical and financial assistance for relief from imminent hazards in small watersheds, and reducing vulnerability of life and property in small watershed areas damaged by severe natural hazard events; and
- Provide guarantee loans made by eligible lenders for water and waste disposal facilities and other essential community facilities including Public Safety, Health Care, and Public Service facilities. Eligibility: public and private non-profit organizations. Borrowers in rural areas can receive $10,000 for water and waste disposal facilities for $20,000 for other community facilities.

**Address:** 101 SW Main St. Suite 1300, Portland, OR 97204
**Phone:** (503) 414-3366

### USDA - Rural Housing/Utilities services

USDA's Rural Development/Utilities services is involved with:

- Grants, loans, and technical assistance in addressing rehabilitation, health, and safety needs in primarily low-income rural areas; and
- Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.

**Address:** Community Programs
**Phone:** (202) 720-1502

### USDA – National Resource Conservation Service (NRCS)

USDA-NRCS is involved with:

- Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events;
- Technical, educational, and limited financial assistance to encourage environmental enhancement community facilities;
- Technical assistance for run-off retardation and soil erosion prevention to reduce hazards to life and property; and
- Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes.

**Address:** National Office
**Phone:** (202) 690-0848

### United States Geological Survey (USGS)

USGS is involved with:

- Developing topographic quadrangles for use in mapping of flood and other hazards; and
- The USGS conducts research on the conditions, issues, and problems of the natural resources in the nation. This information is useful for natural hazards mitigation and planning and is provided by USGS through its publications, maps, brochures and educational guidebooks. USGS also maintains websites at its various regional centers.

**Address:** USGS Oregon District Office, 10615 S.E. Cherry Blossom Dr., Portland, OR 97216,
**Phone:** (503) 251-3200
**Website:** http://www.usgs.gov
**Email**: dc_or@usgs.gov

## Additional Resources

### American Red Cross

The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill and Tillamook counties. The American Red Cross is a humanitarian organization, led by volunteers, that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Chapter provides a variety of community services consistent with the Red Cross mission and meets the specific needs of this area, including disaster planning, preparedness, and education.

**Address:** American Red Cross, Oregon Trail Chapter, P.O. Box 3200, Portland, OR 97208-3200
**Phone:** (503) 284-1234
**Website:** http://www.redcross-pdx.org
**Email:** info@redcross-pdx.org

### Institute for Business & Home Safety (IBHS)

IBHS was created as an initiative of the insurance industry to reduce damage and losses caused by natural disasters. Their website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

**Address:** IBHS, 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
**Phone:** (813) 286-3400
**Website:** http://www.ibhs.org
**Email**: info@ibhs.org

### Natural Hazards Center at the University of Colorado, Boulder

The Natural Hazards Research and Applications Information Center, located at the University of Colorado, Boulder, Colorado, USA, is a national and international clearinghouse that provides information on natural hazards and human adjustments to these risks. The center's prime goal is to increase communication among hazard/disaster researchers and those individuals, agencies, and organizations who are actively working to reduce disaster damage and suffering. The Natural Hazards Center carries out its mission in four principal areas: information dissemination, an annual workshop, research, and library services.

**Address:** University of Colorado, 482 UCB, Boulder, CO 80309-0482
**Phone:** (303) 492-6818
**Website:** http://www.colorado.edu/hazards/
Email: hazctr@colorado.edu

### Department of Land Conservation and Development (DLCD) - Planning for Natural Hazards: The Oregon Technical Resource Guide

This is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local staffs and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can write, call or fax to obtain this document.

**Contact:** Natural Hazards Program Manager
**Address**: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Website:** http://www.lcd.state.or.us/hazards.html

### Association of Contingency Planners, International

Internet Resource

**Website:** http://www.acp-international.com/

### Health and Human Services Department

Internet Resource

**Website:** http://ndms.dhhs.gov/index.html

### International Association of Emergency Managers (IAEM)

Internet Resource

**Website:** http://www.iaem.com/

### The National Domestic Preparedness Office, FBI

Internet Resource

**Website:** http://www.ojp.usdoj.gov/odp

### Oregon Emergency Management Association (OEMA)

Internet Resource

**Website:** http://www.oregonemergency.com/

### Association of State Floodplain Managers

Internet Resource

**Website:** http://www.floods.org/

### CBS News Disaster Links

Internet Resource

**Website:** http://cbsnews.com/network/htdocs/digitaldan/disaster

### The National Emergency Management Association (NEMA)

Internet Resource

**Website:** http://www.nemaweb.org/index.cfm

### National Voluntary Organizations Active in Disasters

Internet Resource

**Website:** http://www.nvoad.org/

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## Multi-Hazard Endnotes

[1] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/emergency/emergency_eoc.html, (Accessed 4/30/03) (Entire Paragraph)

[2] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/emergency/emergency_errp.html, (Accessed 4/30/03) (Entire Paragraph)

[3] City of Beaverton Web Page, http://ci.beaverton.or.us/departments/emergency/, (Accessed 4/30/03) (Entire Paragraph)

[4] City of Beaverton Web Page, http://ci.beaverton.or.us/departments/cdd/, (Accessed 5/2/03) (Entire Paragraph)

## Chapter 7
# Flood Hazards

# Table of Contents

# Why are Floods a Threat to Beaverton?

The City of Beaverton has a long-standing, historic relationship with flooding, including repetitive flood losses. Due to the City's ongoing growth and development, Beaverton faces potential increased frequency of flooding; development generally removes vegetation and increases impervious surfaces, a combination that increases storm water runoff and velocity.

## History of Flooding

Beaverton residents share a statewide concern regarding flood events. According to the National Flood Insurance Program (NFIP), Oregon has 256 flood-prone communities throughout the state's 36 counties.[1] That number includes a majority of Oregon's 240 incorporated communities and counties, of which Beaverton is one. Flooding can cause severe damage to public and private property and pose a threat to life and safety. Oregon's largest economic loss from natural disasters resulted from flooding.[2] Damage during the Christmas Flood of 1964 totaled over $157 million dollars, and 20 Oregonians lost their lives.[3]

In 1996, many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels (flood levels that have a 1% annual chance of occurring). Washington County sought and received a Presidential Disaster Declaration to obtain federal assistance for its flood recovery effort in February 1996. Fortunately, in Beaverton, the intensity of the storms experienced locally didn't approach the predicted 100-year flood event potential (1% annual chance of occurring). For example, the February event levels were only slightly higher than a 10-year flood event; however, several creeks rose to these levels a number of times over three consecutive days. A November 1996 flood event on Beaverton Creek neared a 10-year flood event (10% annual chance of flooding), and, within the City limits, Fanno Creek flooded to slightly greater than a 50-year event (2% annual chance of flooding). Within Beaverton, this inundation of low-lying areas caused natural gas line regulators flood, threatening the operations facility of Northwest Natural Gas. Since those events, the company has developed a back-up emergency plan and put backup emergency positions and systems in place.

The flood season for Beaverton extends from late October through April. Historically, the majority of flooding has occurred in Beaverton during December, January, and February, but overall, the times, duration, and extent of flooding in the City is not well documented. The City has considerable areas of existing development in the floodplain, most of which was developed prior to the establishment of the existing floodplain related development codes. Several of these areas have a high potential for redevelopment, as well as several undeveloped areas in the City's floodplains that have the potential for development. Flooding will continue to be a lengthy maintenance and cleanup issue for Beaverton.

The City's most recent flooding incident occurred during the first week of February 2003 when Beaverton received 4.25 inches of rainfall within a 3-

day period. Several areas known to have been affected during heavy rainfall included:

- 144th Avenue north of TV Highway at the south fork of Beaverton Creek - The City posted high water signs for cars passing through.
- Washington County building on Murray Road – Despite the long-term storage of vehicles being prohibited in this floodplain by Ordinance 4060, cars were left overnight in the parking lot. By day break they were sitting in 1' to 2' of water and were being relocated to higher ground by drivers wading out to them.
- West Slope – Shortfalls in the surface water drainage system placed surface water runoff into crawlspaces and basements. Most of these areas were recently annexed by the City and were originally developed when part of unincorporated Washington County.
- Allen Boulevard off-ramp northbound - High flood water from the Pepper Tree area caused flood water a few feet past the fog line. This high level also affected the entrance of the Greenwood. A pump was used all day to redirect the water to Allen Boulevard.
- Catch basin along Highway 217 - Water backed out of the catch basin, rising approximately one foot above the base of the structure.
- Dori Court off Rollingwood - Water backed out of the catch basin due to Fanno Creek's increase in water volume. Beaverton's Mayor (and other concerned citizens) requested sand bags for this area, and a self-serve sand bag site was created for residents.
- 110th Avenue – High water resulted in a gas station closure.
- 101st and Heather – high floodwater was present.

Beaverton Creek, the most significant stream in the community, drains approximately 36 square miles as it flows northwesterly through the major commercial area of Beaverton. Streams in the City include five tributaries to Beaverton Creek: Erickson Creek (South Fork Beaverton Creek), North Johnson Creek, South Johnson Creek, Hall Creek, Willow Creek, and Cedar Mill Creek.

Erickson Creek flows northwesterly through central Beaverton and drains 1.7 square miles. South Johnson Creek flows northerly along the Beaverton western corporate limits and has a 3.7-square mile drainage area. Hall Creek, which drains 3.6 square miles, flows westerly, entering Beaverton Creek just upstream of the Hall Boulevard bridge. Willow Creek, which drains 6.2 square miles, flows westerly through the North Section of Beaverton entering the community just south of Highway 26. Fanno Creek, another significant stream, flows westerly to State Highway 217, then southerly through the City to its confluence with the Tualatin River, after draining 32 square miles. Cedar Mill Creek flows northwesterly and has a drainage area of 8.6 square miles.

There are currently six gauging stations in or near Beaverton for Beaverton Creek, Cedar Mill Creek, Ericson Creek, Johnson Creek, and Willow Creek. [4] The largest flood since 1970 on the creeks in the study area occurred in

December 1977, which had an estimated recurrence interval of approximately 10 years.

As a mitigation effort, several culverts have been enlarged on Beaverton Creek to decrease the flooding frequencies in the City. The City spends on average 1.5 million dollars each year in capital improvement projects for the retrofit of detention facilities and other storm sewer improvements in older sections of the City; these retrofits are designed to reduce the frequency of and to minimize future flooding events. The City also requires storm water detention for all new developments that are a half-acre in size and greater.

Nonstructural measures are also being utilized in the form of flood hazard zoning ordinances that follow FEMA guidelines for controlling development within the 100-year floodplain to ensure that it is reasonably safe from flooding. Except in the downtown area, all fill below the 100-year flood event elevation in new developments must be balanced by an offsetting cut for each one foot of contour. In the downtown area, while unbalanced fill in the floodplain is allowed, all new buildings must be elevated or flood proofed to two feet above the 100-year flood event.

## Repetitive Flood Losses in Beaverton

There are a total of 18 flood loss properties in Beaverton, three of those repetitive losses. The properties are dispersed throughout the City, but concentrations occur near the following locations:

- Highway 217 and Denny Road (Fanno Creek);
- Near 217 between the Beaverton-Hillsdale Highway and Canyon Road (Beaverton Creek); and
- Near the intersection of Murray and Allen Boulevards, along the Johnson Creek corridor.

The potential for property damage from Beaverton Creek flooding is especially severe for several reasons. Inadequate size and moderate grade of the channel causes over-bank flooding during even mild storms. Many culverts and bridges constrict Beaverton Creek flow; additionally, banks that were artificially constricted by farmers in the first half of the last century and the last half of the previous century result in increased upstream flood heights. The potential for property damage is significant due to the extensive commercial and residential development within the Beaverton Creek floodplain. The City experiences flooding frequently from rising creeks and streams as well as localized flooding from overtaxed storm water systems.

Fanno Creek, Johnson Creek, Erickson Creek, and Cedar Mill Creek also have flooding problems, though the flood damage potential from these streams is not as prominent as Beaverton Creek. The floodplains have not been extensively developed on these smaller streams except for residential developments that flood frequently in the Cedar Mill Creek basin upstream from the Nike World Headquarters. The frequency of these damaging events has greatly increased because of numerous recent developments upstream in the basin, outside the City limits, which lack any run-off detention or flow mitigation for large storms.

The National Flood Insurance Program (NFIP) indicates that Beaverton has 3 recorded repetitive loss properties. According to NFIP data dated February 2003, 35 of its policyholders have losses totally $258,186. Each of these three repetitive loss properties has had two losses apiece having total losses of $114,280.[5]

## What Factors Create Flood Risk

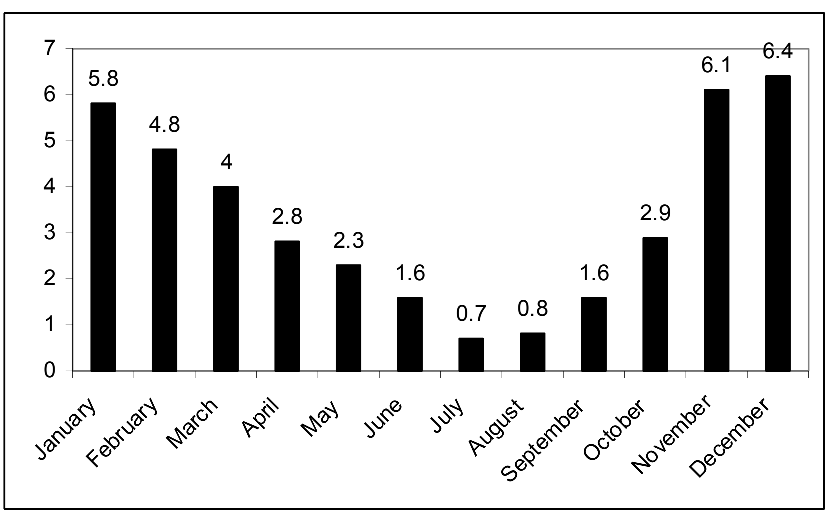
Flooding occurs when climate or weather patterns, geology, and hydrology combine to create conditions enabling water to flow outside of its usual course. In Beaverton, geographic and climatological conditions combine to create a situation of chronic seasonal flooding.

### Precipitation

Flooding is most common from October through April when storms from the Pacific Ocean can bring intense rainfall to the area. The average annual precipitation approximately 39.4 inches, and occurs during these seven wettest months of the year[6]. During this seven-month period, Beaverton receives approximately 81% of its annual precipitation. Snowfall occurs a few days each year, with depths seldom exceeding six inches. Figure 7.1 illustrates the average monthly precipitation that Beaverton receives in inches.

The high level of precipitation during the rainy season saturates the ground, and often fills Beaverton Creek and its tributaries to bank full conditions. Bank full conditions exist when rivers and streams rise and exceed their channel capacity; any additional water begins to encroach into the surrounding floodplain. The City typically experiences flooding after more than three days of heavy rainfall, which results in saturated conditions and during significant rainfall over short periods of time, typically associated with major storms/thunderstorms.

**Figure 7.1. Average Monthly Rainfall for Beaverton, Oregon**




Source: Washington County Natural Hazard Mitigation Plan Geography

### Geography

Beaverton is located in the Willamette sub-region and Tualatin Valley drainage basin. The drainage basin is approximately 43 miles long and 29 miles wide, and covers an area of 712 square miles.[7] An early settler to the area, Peter Ogden, described the area of the 1800s as "mostly water connected by swamps." Soils on the valley floor include poorly drained clay soils.[8] These soils often form into wetlands because they are capable of holding water for extended periods of time.

The broad floodplain of the valley can be easily inundated by floodwaters. Wet, rainy season storms move in from the Pacific Ocean, dropping heavy precipitation into the "bowl-shaped" valley. Flooding in the valley becomes a problem when human activities infringe on the natural floodplain.

**What is a Floodplain?**

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess floodwater. The floodplain is made up of two sections: the flood fringe and the floodway.

**What is the Floodway?**

The floodway is one of two main sections that make up the floodplain. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

**What is the Flood Fringe?**

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

### Soils

Soils in and around Beaverton are silt loams ranging from being nearly level to steep slopes. Drainage characteristics for those soils are poor along the level areas of the Beaverton floodplains. Drainage improves on sloping terrain.

## Floodplain Terminology

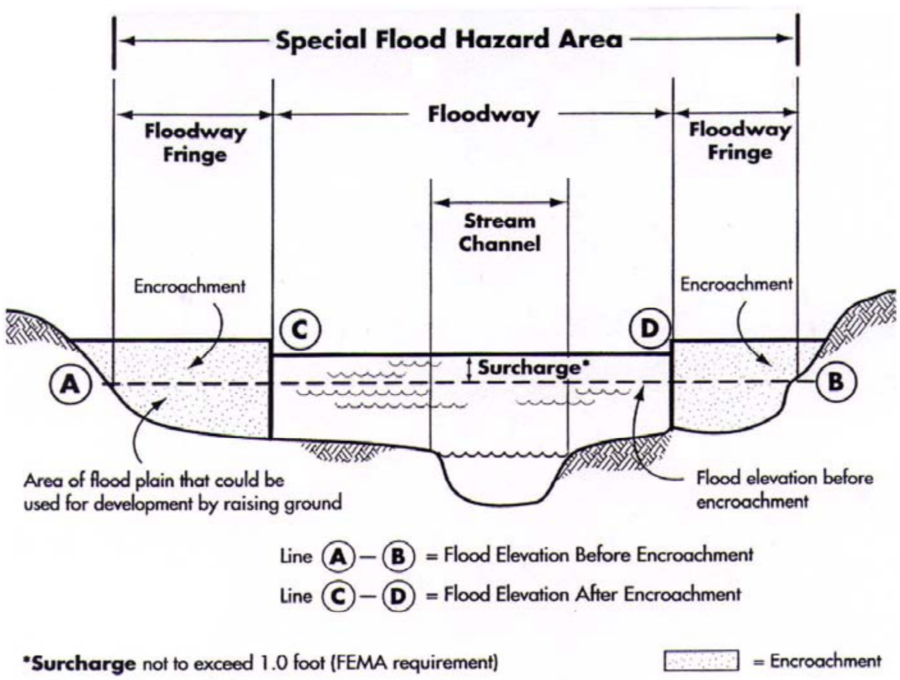
### Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe. See the Natural Hazards Map in this plan's Map Section for Beaverton's 100-Year Floodplain.

### Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined only for regulatory purposes; unlike floodplains, floodways do not reflect a recognizable geologic feature or floodwater path. The City uses the NFIP floodway definition, which is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.[9] The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. The City of Beaverton regulations prohibit development in the floodway, with certain exceptions. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

**Figure 7-2. Floodplain Schematic**




Source: Floodplain Management in Missouri. (March 1999) Missouri Emergency Management Agency

## Flood Fringe

The Floodway Fringe is the area of the floodplain lying outside the floodway that does not contribute appreciably to the passage of flood water, but serves as a retention area[10]. The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. The City's Development Code provides requirements for commercial and industrial as well as residential uses within the fringe. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

## Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929, the North American Vertical Datum of 1988, or other datum referenced in the Flood Insurance Study report, or average depth of the base flood, usually in feet, above the ground surface.[11] Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.[12]

## Characteristics of Flooding in Beaverton

Two types of flooding primarily affect Beaverton: *urban* flooding and *riverine* flooding. In addition, any low-lying area has the potential to flood. Flooding of developed areas may occur when the amount of rainfall and runoff exceeds a storm water system's (creek, ditch, or storm drain) capability to remove it. Unlike some urban areas, all storm water runoff in Beaverton is directed to the nearest creek or stream. At no point is storm water intentionally directed into the sanitary sewer system.

### Urban Flooding

Urbanization of the watershed changes the hydrologic systems of the basin. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and then slowly release rainfall. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. The resulting high water volume and turbidity both contribute to erosion of stream banks.

A majority of land within Beaverton is urbanized, and has a high concentration of impervious surfaces that either collect water or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins often back up with vegetative debris causing additional, localized flooding.

There are currently numerous areas subject to urban flooding and the potential exists for more as development continues throughout Beaverton. The continual increase of impervious surfaces related to development significantly contributes to Beaverton's future flood risk as a result of increasing runoff subsequently exceeding the capabilities of existing drainage infrastructure.

### Riverine Flooding

Riverine flooding, the overbank flooding of rivers and streams, is the largest single form of flooding in Beaverton. Streams in the City regularly overflow their banks and inundate low-lying areas. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers.[13]

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as *"areas that are inundated by the 100-year flood with flood depths of only 1 to 3 feet."* These areas are generally flooded by low-velocity sheet flows of water.

## What is the Effect of Development on Floods?

When structures or fill are placed in the floodway, water is displaced. Development raises the base flood elevation by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway, and no fill is removed to compensate, serious problems can arise. Floodwaters inundating the area may expand beyond their historic floodplain areas, possibly resulting in other existing floodplain areas experiencing floodwaters above historic levels.

Local governments must manage development in floodplains and flood ways to assure that any encroachments in the floodway or floodplain are minimized. This can be by cut and fill balance and other methods to prevent the rise of pre-development flood levels. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention must be paid to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events without exacerbating flood levels.

Development within the floodway is prohibited in City of Beaverton's Development Code, (60.10.15). The following exceptions are allowed, but are subjected to the site development ordinance (B.C. 9.05.005 to 9.05.170):

A. Storm water outfall pipes and other drainage improvements;

B. Bridges;

C. Culverts;

D. Public utility lines;

E. Trails or bike paths;

F. Roads and other uses identified in the City's Transportation Plan; and

G. Grading associated with A through F above.

The City's site development ordinance prohibits encroachments, including fill, new construction, substantial improvements, and other development unless certification by a registered professional engineer or architect is provided demonstrating that encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge.[14] The city engineer will also deny a permit for development in an area of special flood hazard if the city engineer finds that any of the following circumstances exist[15]:

- The proposed development will diminish the flood carrying capacity of the watercourse;

- The proposed development does not maintain the holding capacity of the site;
- The proposed development will significantly raise the flood surface elevations up or down stream from or adjacent to the site;
- The proposed development will endanger life or property on or off the site;
- Where elevation data is not available either through the Flood Insurance Study or from another authoritative source, proposed construction will not be reasonably safe from flooding. The test of reasonableness is a local judgment and includes use of historical data, high water marks, photographs of past flooding, etc., where available. Failure to elevate at least two feet above grade in these zones may result in higher insurance rates.
- All necessary permits have not been obtained from those federal, state or local governmental agencies from which prior approval is required.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of stormwater management systems to ensure that these runoff waters are dealt with effectively.[16] In Beaverton, this is accomplished by the detention of large storm events to mimic pre-development run-off rates.

## How are Flood-Prone Areas Identified?

Flood maps and Flood Insurance Studies are often used to identify flood-prone areas. The National Flood Insurance Program (NFIP) was established in 1968 as a means of providing low cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and what we have come to know as "sound floodplain management."[17] Beaverton and Washington County joined the NFIP and implemented the related codes and regulations in 1974. NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60.3) require that all new construction in floodplains must be elevated at or above base flood level. The Oregon Building Code requires new construction to be elevated to one foot above the base flood elevation.

Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent.[18] In Beaverton, all homes and other buildings legally constructed in the floodplain after January 1974 must be mitigated to NFIP standards with the first floor being elevated at least one foot above base flood level, or in the case of non-residential buildings, flood proofed to at least one foot above the base flood level.

### FIRM Maps and Flood Insurance Studies

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance

Rate Map (FIRM) is the official map produced by the Federal Emergency Management Agency (FEMA), which delineates Special Flood Hazard Areas or floodplains where National Flood Insurance Program regulations apply. The maps are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

The City of Beaverton considers the 100-year (1% annual chance of flooding) flood as the base flood event.

Water surface elevations are combined with topographic data to develop FIRMs. These maps illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.

Flood Insurance Studies and FIRMs produced for the National Flood Insurance Program (NFIP) provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies. *They do not reflect changes within the study area that might affect flooding since the studies.* For example, many areas in Beaverton have experienced significant urbanization and changes in hydrology during the past 20 years. The City Engineer and Planning Director have records of subsequent flood studies performed for new developments in areas where the FEMA maps were deficient or with previously unstudied flood hazards. Floodplain maps within most of,

***Development:***

For floodplain ordinance purposes, development is broadly defined to mean "any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations or storage of equipment or materials." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

***Base Flood Elevation (BFE)***

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level), which the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, using lower frequency events for others. For example, for the purpose of stormwater management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the National Flood Insurance Program focus on development in the 100-year floodplain and the City of Beaverton, has established the 100-year flood as the base flood event.

but not all of, urban Washington County are being updated and the updates were submitted to FEMA for review in July 2003.

### Flood Mapping Methods and Techniques

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, some jurisdictions develop their own flood hazard maps, like Beaverton. They use high-water marks from flood events or aerial photos, in conjunction with the FEMA maps, and all new studies to better reflect the true flood risk for properties within their communities.

The use of GIS (Geographic Information System) is becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS, which then allows for GIS analysis of flood hazard areas. Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. However, as the original mapping efforts by FEMA in the 1980's did not contain adequate horizontal controls, any such overlay is subject to significant error. Local communities have found that the only useful mapping information is the water elevation and cross section locations contained in the flood studies. This information can be added to topography maps that more accurately define the areas prone to flood hazard. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request.

Coordination between FEMA and local planning jurisdictions is the key to making a strong connection with GIS technology for the purpose of flood hazard mapping. Clean Water Services in cooperation with several Washington County cities, including Beaverton, received a grant from FEMA to update the floodplain maps for urban Washington County. The revised maps were submitted to FEMA in July 2003. FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcView© and ArcInfo©. The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site will assist communities in evaluating geographic information about natural hazards. Flood information for most Oregon communities is available on the ESRI web site. Visit http://www.esri.com for more information.

## Community Flood Issues

Development in the floodplains of Beaverton will continue to be at risk from flooding. Flood damage occurs on a regular basis throughout the City. During certain years, property losses resulting from flood damage can be extensive. NFIP payment for 1996 flood damages for all of Washington County was 531 times greater that the three previous years combined.

The single largest impact on communities from flood events is the loss of life and property. Washington County has experienced millions of dollars in flood damage in the past three decades, with Beaverton's losses reflecting a subtotal of this amount. Property loss from floods strikes both private property and public property. Public sector impacts (e.g., impacts to water and sewer systems, roads, etc.) state-wide resulted in approximately two-thirds of the damage from the 1996 flood events.[19]

In a survey of stakeholders, Clean Water Services (CWS, formerly Unified Sewerage Agency) found that stakeholders desired a greater connection between flood control, water quality, the mitigation of growth impacts, and the effectiveness of land use systems. Many citizens are concerned about the relationship between rapid urban growth and flood damage. While there are no strong sentiments to stop growth, some Beaverton residents are concerned that growth is pushing development into floodplains. CWS manages wastewater treatment and sets minimum standards for surface water management within the urbanized area of Washington County. The City of Beaverton sets higher standards for control of damaging run-off rates from new developments than are used by Clean Water Services for areas outside the current City limits.

### Property loss resulting from Flooding Events

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive flood damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Surface water entering into crawlspaces, basements, or daylight basements is common during flood events, not only in or near floodplains, but also on hillsides and other areas that are far removed from floodplains.[20] Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Most of the losses in the 1996 floods were due to saturation damage.

### Private property flood issues

In 1996, flood damage to private property totaled one-third of damages statewide.[21] In Beaverton, damage occurred to structures in the floodplain, as well as structures impacted by localized urban flooding, but not necessarily in the FEMA-mapped floodplain. Damage also occurred to structures impacted by landslides caused by heavy precipitation. A high level of flood damage during the 1996 floods occurred to those structures that were constructed prior to the adoption of floodplain management measures required by the National Flood Insurance Program. The concentration of damage clearly demonstrates the success of the mitigation measures required and implemented through the NFIP.[22]

The City of Beaverton regulates floodplain development in the City Code (Chapter 9), the Development Code (Chapter 60), and the City's Engineering Design Manual (Ord. 4060). Flood events also pose a risk to structures outside of identified floodplains. Outside of official floodplains the City also provides drainage standards under the Development Code, Engineering Design Manual and under Clean Water Services' drainage standards.

### Homes

Housing losses accounted for the largest share of private property damage during the 1996 flood events.[23] Homes with access to rivers and creeks may be located in areas especially at risk to chronic flooding. Beaverton flood ordinances provide baseline rules governing the construction of homes within identified floodplains. Flood damage problems may continue to arise for homes that were constructed prior to the implementation of the City regulations and the Washington County Floodplain and Drainage Hazard Area Development Standards. Flood damage may also occur to homes constructed according to standards, as the County and City cannot guarantee that adherence will prevent flood damage.[24]

Homes in frequently flooded areas can also suffer damage to septic systems and drain fields. Homes in rural floodplain areas often depend on private sewage treatment systems. Inundation of these systems may result in leakage of wastewater into surrounding areas. In many cases, flooding damage to homes renders them unlivable.

In the wake of the 1996 floods, Washington County received almost $1.5 million in Disaster Housing Assistance Program funds with a portion of that allotment dedicated to assist Beaverton in its post-flood recovery period. The Federal Government provides disaster funding for people who cannot, or should not, live in their homes because of damage or other disaster related reasons.[25]

Table 7.1 illustrates Washington County's rank as the seventh highest county in the state for total flood damage during the 1996 events, and as the fourth highest county for housing disaster assistance. Housing Assistance funds went primarily to urban counties with high populations and relatively high property values.[26]

## Table 7.1. 1996 Oregon County Losses and Housing Program Fund Payments

| County Losses | Housing Fund Payments to Counties |
|---|---|
| 1.) Tillamook | 1.) Clackamas |
| 2.) Clackamas | 2.) Marion (tied) |
| 3.) Multnomah | 2.) Columbia (tied) |
| 4.) Marion | **4.) Washington** |
| 5.) Columbia | 5.) Multnomah |
| 6.) Lane | 6.) Tillamook |
| **7.) Washington** | 7.) Linn |

Source: 1996 Flooding and Landslides and Stream Erosion In the State of Oregon

### Manufactured Homes

Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61% were mobile homes and trailers.[27] Many older manufactured home parks are located in floodplain areas. Manufactured homes have a lower level of structural stability than "stick-built" (standard wood frame construction) homes. A stick-built home's foundation and building frame are put together on site as opposed to manufactured homes which are pre-fabricated off site.[28] Manufactured homes in floodplain zones must be anchored to provide additional structural stability during flood events. Because of confusion in the late 1980's resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements. Lack of enforcement of manufactured home construction standards in floodplains can contribute to severe damages from flood events.[29] In all areas of special flood hazards Beaverton's Development Code requires that all new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure. Additionally, all manufactured homes must likewise be anchored to prevent flotation, collapse or lateral movement, and shall be installed using methods and practices that minimize flood damage.[30]

#### Business/Industry

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. The 1996 flood damaged some businesses in Beaverton and caused extensive losses to Washington County's agricultural and nursery-stock industries. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.[31]

The Beaverton Creek floodplain includes existing commercial development and potential commercial sites from Millikan Way (near 160th Avenue) to upstream of State Highway 217. Along Fanno Creek, both commercial and residential development sites are in the floodplain from Vermont Street to Scholls Ferry Road where it flows into the City of Tigard.

### Public Infrastructure

Publicly owned facilities are a key component of daily life for all citizens of Beaverton. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Government can take action to reduce risk to public infrastructure from flood events, and to craft public policy that reduces risk to private property from flood events.

#### Buildings and Roads

In the wake of the 1996 flood events, damage to public buildings statewide represented 34% of total public losses.[32] Of particular importance during flood events are critical facilities located in flood hazard areas (i.e., facilities that are critical to government response and recovery activities). During natural hazard events, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. The roads in Beaverton are maintained by multiple jurisdictions depending on ownership and maintenance agreements. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. More than 50% of public assistance appropriations to Washington County following the 1996 floods were to repair damages to the road system.[33] Road networks often traverse floodplain and floodway areas. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

### Bridges

Bridges are key points of concern during flood events for two primary reasons:

(1) They are often important links in road networks, crossing water courses or other significant natural features; and,

(2) They can be obstructions in watercourses, inhibiting the flow of water during flood events.

### Storm Water System

Local drainage problems are common throughout Beaverton. The City's Operations and Maintenance Department maintains a list of local drainage threats and potential problem areas. The problems often are located where open ditches enter culverts or go underground into storm sewers. In addition, high water tables in some areas can mean wet crawl spaces, yards, and basements following a flooding event because the accumulated water does not drain quickly into a stream or storm sewer. The problem is compounded when ditches and swales near buildings are filled or when debris dumped in them inhibits or prevents the flow of water. Most of the areas where these problems exist were recently annexed by the City and were originally developed when part of unincorporated Washington County. Inadequate maintenance, especially following leaf accumulation in the fall, could contribute to the flood hazard.[34] In Beaverton aggressive leaf removal, catch basin cleaning, and street sweeping programs have all but eliminated these types of flood events in the City limits.

### Water/Wastewater Treatment Facilities

Portions of Washington County, including a small percentage of Beaverton are served by the Tualatin Valley Water District. But most of the City is served by the City's water district. The Beaverton Water District draws the bulk of its water from the watersheds located on the west side of Washington County and is able to draw from Bull Run as a backup source. The Joint Water Commission (JWC) Water Treatment Plant processes water from Hagg Lake, (routed through Scoggins Creek and the Tualatin River) and Barney Reservoir. The plant faces significant risk during flood events.

During the February 1996 flood events, the JWC Plant was surrounded on all sides by floodwaters.[35] The plant was able to maintain operations by instituting emergency procedures. In 2001, the JWC began developing an emergency operations plan that will assist management during hazard events. The JWC faced another significant challenge during the 1996 events—treating water with high levels of turbidity (sedimentation). According to the JWC Plant Operations Manager, water turbidity during the 1996 events was "something we had never seen before." The JWC Plant can treat high turbidity levels in the water. However, the cost of treating the water increases with turbidity levels. High turbidity levels can be attributed to land use practices up stream that result in increased erosion (e.g., vegetation removal and landslides). Changes in land use practices within the watershed could assist in reducing turbidity levels during flood events. The problem with turbidity will also be reduced greatly when a planned pipeline is built from Hagg Lake to the water treatment plant, eliminating the need to use Scoggins Creek/Tualatin River to convey the water from the reservoir to the treatment plant.

Clean Water Services (CWS) operates four wastewater treatment plants in the Tualatin Basin at Durham Creek, Rock Creek, Hillsboro, and Forest Grove. The wastewater treatment plant facilities are located adjacent to the floodplain and were not flooded in 1996. Since the system is built to a target capacity based on a 5-year idealized storm, the volume of water entering the plants during flood events can be problematic. A new wet weather outfall was recently installed at Rock Creek in Beaverton to improve discharge capacity and structures at risk of flooding have been elevated/flood proofed. CWS is working to improve the tightness of the conveyance system to minimize treatment of non-sewage waters. All four wastewater treatment plants have back-up emergency power supplies. Also, the Forest Grove and Hillsboro plants are linked to the Rock Creek plant, so if there were problems at these smaller facilities, the sewage could be treated at Rock Creek.

## Floods and Natural Systems

Maintaining and restoring natural systems can mitigate the impact of flood events on the built environment. Flooding changes the natural environment and hydrology of an affected area. High water can also be beneficial to the natural processes within a floodplain, and can benefit riparian areas.

### Parks and Open Space

Current efforts to increase public open space in Beaverton have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property.

### Riparian Areas

Riparian areas are important transitional areas, which link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water such as willow and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion.[36] During flood events, high water can cause significant erosion. Well-managed riparian areas can reduce the amount of erosion and help to protect water quality during flood events.

### Wetlands

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system.[37] Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning stormwater runoff and for tertiary treatment (polishing) of wastewater. Wetlands bordering streams and rivers and those that intercept runoff from fields and roads provide this valuable service free of charge.[38]

#### Water Quality

The Tualatin River and Beaverton Creek are part of a sediment-based system. High turbidity is part of its “normal” condition due to the dominance of silts and clays on the valley floor. Streams naturally carry some quantity of sediment (called bed load). When the scouring and deposition of sediments is excessive (i.e., beyond normal bed movement) turbidity becomes a problem in the stream. High flows can generate very high turbidity and suspended solids in the main stem and many of the tributaries. Significant flood events in 1995 and 1996 have increased concern for flood management and control in the watershed.

### Title 3: (Metro Code 3.07.310-3.07.370), Water Quality and Flood Management Conservation[39]

The goal of the Stream and Floodplain Protection Plan (Title 3) of Metro Regional Government’s Framework plan is to protect the region's health and public safety by reducing flood and landslide hazards, controlling soil erosion, and reducing pollution of the region's waterways. Title 3 implements Oregon Land Use Goals 6: Air, Water, and Land Resources Quality and 7: Areas Subject to Natural Disasters and Hazards, by protecting streams, rivers, wetlands, and floodplains by avoiding, limiting, or mitigating development impact on these areas.

Title 3 contains performance standards to protect against flooding. The standards limit development in a manner that requires balanced cut and fill, and requires floor elevations at least one foot above the flood hazard standard. The areas subject to these requirements have been mapped and adopted by Metro Council. The areas are the FEMA 100-year floodplain and the area of inundation for the February 1996 flood. Title 3 also contains performance standards related to streams, rivers, and wetlands.

The purpose of these standards is to protect and allow enhancement of water quality. The water quality areas are rivers and streams with a protected vegetated corridor width depending on the slope of the stream and the number of acres drained by the stream. The performance standards require erosion and sediment control, planting of native vegetation on the stream banks when new development occurs, and prohibition of the storage of uncontained hazardous material in water quality areas.

# Flood Hazard Assessment

## Hazard Identification

Hazard identification is the first phase of flood hazard assessment. Identification is the process of estimating (1) the geographic extent of the floodplain (i.e., the area at risk from flooding), (2) the intensity of the flooding that can be expected in specific areas of the floodplain, and (3) the probability of occurrence of flood events. This process usually results in a floodplain map. Floodplain maps provide detailed public information that can assist planning jurisdictions in making policy and land use decisions. In Beaverton, the City, the Army Corps of Engineers, the Federal Emergency Management Agency (FEMA), and Clean Water Services develop floodplain maps. Each map of the floodplain provides important data for determining the areas that fall within the floodplain. To identify the flood hazard area, or floodplain, Beaverton uses the maps from all three agencies in addition to maps developed over the years by City staff. The map that is used depends upon the specific parcel or area in question, and which map provides the best available data for that area.

### Data Sources

In 1980, FEMA mapped the 100-year and 500-year floodplains in Washington County. The County has updated portions of the Corps and FEMA maps through smaller drainage studies throughout the County. The County also provides 25-year floodplain data for Tualatin River tributaries, such as Beaverton Creek, also referenced as the County's Drainage Hazard Areas. Clean Water Services (CWS) in partnership with Washington County and several cities is currently in the process of updating floodplain data. It is hoped that the CWS data will become the best available data when it is completed.

Beaverton's GIS Services plays an important role in creating maps using existing data for the purpose of identifying high-risk flood areas. Important to note is the fact that the FEMA floodplain map does not match the City's building footprint maps, creating the erroneous impression that some structures are in the floodplain while other structures shown outside the floodplain are actually within.

## Vulnerability Assessment

Vulnerability assessment is the second phase of flood hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. It identifies the number of properties at risk from flooding, and the dollar value of the property at risk. Floodplain data for Beaverton can be used to conduct a preliminary vulnerability assessment for flood and drainage hazard areas.

The floodplains in Beaverton are generally located along Beaverton Creek, Fanno Creek, and its tributaries. There are approximately 750 acres within the 100-year floodplain boundaries in the City's jurisdiction. A total of 845.69 acres of tax lots that lie within the 100-year flood plain in Beaverton. Within the tax lots, there are 320 total structures valued at $339,537,830. See Table 7.2 for a breakdown of these properties by types of tax lots.

**Table 7.2. Vulnerability Assessment for the 100-year Floodplain**[40]

| Building Code Category | Number of Properties | Assessed Improved Value | Acreage within 100-year floodplain |
|---|---|---|---|
| COMMERCIAL | 34 | $78,014,890 | 103.26 |
| INDUSTRIAL | 39 | $126,973,670 | 226.27 |
| SINGLE FAMILY RESIDENTIAL | 199 | $29,201,790 | 171.75 |
| MULTI-FAMILY RESIDENTIAL | 48 | $105,347,480 | 344.41 |
| **TOTAL** | **320** | **$339,537,830** | **845.69** |

Source: City of Beaverton GIS, 2003

## Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. As such, it builds upon the hazard identification and vulnerability assessment.

A flood risk analysis for Beaverton should include two components:

(1) The amount of loss to both property and life that may result from a flood event (defined through the vulnerability assessment); and,

(2) The number of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events. For example, a risk analysis can be conducted for both 25-year (smaller storm) floodplains (Drainage Hazard Areas), and 100-year (larger storm) floodplains. Over time, the Drainage Hazard Areas will flood more often than areas within a 100-year floodplain, exposing properties in Drainage Hazard Areas to a greater risk of flood damage. However, depending on the impacts resulting from a 25-year flood event versus a 100-year flood event, and the amount of life and property exposed to the different hazard events, the level of risk may vary.

Empirical data, such as NFIP insurance claims, can also help establish where risk is greatest, particularly for properties that have had multiple (repetitive) losses.

Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events. The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event. GIS technology and flow velocity models make it possible to map the damage that can be expected from both flood events over time. It is also possible to pinpoint the effects of certain flood events on individual properties.

At the time of publication of this plan, data was insufficient to conduct a full risk analysis for flood events in Beaverton. However, fostering partnerships between the City, Clean Water Service and the State Floodplain Manager will help support development of improved floodplain data for the City. This plan includes recommendations for building partnerships that will support the conducting a future flood risk analysis in Beaverton.

# Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Partnerships for Communication and Coordination
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

## Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations. Several personal stakeholder interviews were conducted with several Beaverton agencies to obtain existing mitigation activities information.

### City Programs

#### City of Beaverton Codes

Flood-related goals, actions, and or regulations can be found in Beaverton's Comprehensive Plan, Development Code, City Code, and Engineering Design Manual.

#### Flood Management Projects

As stated earlier, the City spends approximately $1.5 million each year on flood mitigation projects like the ones identified below. A majority of the City's projects deal with underground detention facilities. Flood management structures (i.e., dams) can assist in regulating flood levels by adjusting water flows upstream of flood-prone areas. The expense and space needs of large water detention projects to mitigate flood damages can be a prohibitive factor for local jurisdictions such as Beaverton. Flood detention and conveyance projects are also potential solutions to flood damage issues. However, detention or conveyance projects may not always be the most cost-effective way to decrease flood damages especially in high frequency or severely flood-prone areas. Individual property mitigation projects within an affected area may be more effective at reducing flood damage, and less expensive than large detention or conveyance projects that may simply shift the problem downstream.[41]

Additional flood control projects may include levees, diversions, and channel modifications. Levees provide a barrier of earth, steel, or concrete erected between the watercourse and the property to be protected. However, levees may result in the displacement of floodwaters to surrounding properties. Diversion channels direct floodwater to a different location, reducing damage to property within the floodplain or floodway. Diversions may protect certain properties; however, water diversion may force flood impacts onto new areas. Channel modifications increase the capacity of a stream or river channel to carry water. Channel modifications may not be appropriate for sensitive natural systems within riparian areas.

### Emergency Management Program

Beaverton's Emergency Management Program coordinates available resources to combat emergencies. The program's goals are to effectively save lives, avoid injury, and minimize economic loss. Today's Emergency Management Program evolved from Civil Defense and Civil Preparedness programs of the 1950s, 60s, and early 70s. Other City departments work in conjunction with the Emergency Management Program. The goal of the program is to develop and maintain the City's ability to prepare for, respond to, recover from, and mitigate against major emergencies and disasters and to minimize loss of life and property, ensure continuity of government, and facilitate rapid recovery.

The City has established an Emergency Management Program consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). It is organized under the auspices of the City Council and works under the overall supervision of the Mayor. The Emergency Manager is part of the Mayor's Office and is responsible for managing the City's program in all four phases of Emergency Management. The responsibilities of the City's Emergency Manager include:

- Development and maintenance of the City's Response, Recovery, Preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies

## County Programs

### Office of Consolidated Emergency Management

The City of Beaverton's Emergency Management Program is an integral part of the Office of Consolidated Emergency Management (OCEM) in

Washington County. OCEM was established in 1995 by an intergovernmental agreement between the City of Beaverton, the City of Hillsboro, Washington County, and Tualatin Valley Fire and Rescue. OCEM was formed to improve the level of disaster and emergency preparedness within the boundaries of the participating jurisdictions through increased coordination among OCEM members and among the various emergency service functions provided within each participating jurisdiction.

## Washington County Codes

The Community Development Code, *Section 421: Floodplain and Drainage Hazard Area Development*, was first adopted in November 1973, and became effective in January 1974. The current standards were adopted in 1983, and revised in subsequent years. These standards directed that the 1974 Corps of Engineers maps and the 1980 FEMA Flood Insurance Rate Maps, including the Flood Boundary and Floodway Maps be used to determine the floodplain, floodway, and Drainage Hazard Areas of Beaverton. These were later changed, most significantly in 1984, 1987, and 2000 as new FIRM maps and Letters of Map Revisions were adopted. All lots of record established after 1974 have buildable area outside of the delineated floodplain or Drainage Hazard Area boundaries. Legal lots of record established prior to 1974 may not have buildable area outside of the floodplain. Any building within the floodplain must adhere to the provisions in Section 421.

### Affected Properties

Section 421 provides development guidelines for properties in the floodplain, and properties that are within 250 feet of a delineated floodplain. The floodplain is determined through the use of maps and data from FEMA, Army Corps of Engineers, Washington County, Beaverton, and Clean Water Services. The County policy is to use the most current data available to delineate the floodplain in relation to property lines.

### Mitigation Requirements

Section 421 requires the following:

- Landowners must submit a detailed delineation of the floodplain in areas planned for development.
- All fill below flood surface elevation (i.e., in the floodplain) be accompanied by an equal or greater amount of cut on the development site.
- Landowners are allowed to avoid the on-site requirement of the cut and fill rule by developing a drainage master plan for the site, or providing off-site excavation to meet the amount of cut required to balance the fill in the floodplain.
- Construction of a new dwelling in the floodplain is prohibited if the property in question has a suitable site for development that is not in the floodplain.

- All new or improved residences (including manufactured homes), and lots for subdivisions and partitions must be elevated at least 1 foot above base flood elevation.
- All new or improved non-residential buildings must be flood-proofed, or elevated to or above base flood elevation

## Regional Surface Water Management

Clean Water Services (CWS) sets minimum surface water management standards for all municipalities in the County, and those urban, unincorporated areas within the urban growth boundary. CWS has adopted surface water standards with respect to flood management while the City of Beaverton has adopted more stringent standards to control and mitigate for flood events. The Surface Water Management Program, in coordination with local jurisdictions, seeks to provide and maintain urban area surface water management facilities, policies, practices, and controls that protect the public's health, safety, and property. The program also seeks to conserve, and where possible, enhance and restore, the natural systems of Beaverton Creek and its tributaries. CWS is authorized by State law to set fees and charges for connection to and use of, the public facilities and public services related to surface water management.[42] However, inside the City limits, the City of Beaverton collects all fees and charges for connection to and use of public facilities and services related to surface water management.

## Healthy Streams Plan

Clean Water Services began the development of the Healthy Streams Plan concept in October of 1999, following the listing of winter steelhead and spring Chinook as threatened species under the Endangered Species Act. The purpose of the project is to develop a watershed-based plan that integrates the requirements of the Clean Water Act (CWA) and the Endangered Species Act (ESA) in a manner that promotes overall stream health. The plan will identify and prioritize specific projects, policies, and programmatic changes needed to further improve water quality, manage flooding and floodplains, and provide for aquatic species recovery throughout the Tualatin River Basin. The Healthy Streams Plan has six major components outlined below in chronological order. All components were completed by winter 2002.

### Actions

- Watersheds 2000 Inventory (topography, ecological survey, hydrology/hydraulic modeling);
- Fish friendly reviews of existing activities;
- Economic analysis and funding strategy development;
- Public values analysis;
- Programmatic and policy focus areas (impervious cover, vegetated corridors, landscape management, hydrology/hydraulics, storm water pretreatment); and
- Document preparation and final plan approval.

Clean Water Services has been working with project partners in the basin including: Washington County, cities in Washington County including Beaverton, Tualatin Hills Park and Recreation District, Metro, the Soil and Water Conservation District, and the Federal Emergency Management Agency.

## Regional Programs

### Acquisition and Protection of Open Space in the Floodplain

Public, private, and non-profit organizations have acquired open space within the floodplain. The City of Beaverton, Washington County, Metro, the City of Hillsboro, and the Oregon Wetlands Joint Venture are among the organizations that have acquired floodplain open space in order to protect natural flood hazard mitigation systems and prevent further development in the floodplain. Clean Water Services owns floodplain open space for use in conjunction with wastewater treatment facilities.

### Regional Emergency Management Group

The City of Beaverton is an active member of the Regional Emergency Management Group (REMG). The REMG was formed in 1993 through an Intergovernmental Agreement between agencies in the five-county, bi-state Portland/Vancouver metropolitan area. The purpose of REMG is to:

1. Recommend policy and procedures on regional emergency management issues;
2. Develop an ongoing, inter-jurisdictional training and exercise program;
3. Establish mutual aid agreements to ensure effective management of resources during an emergency; and
4. Develop a regional emergency management plan.

The REMG has evolved from an informal regional planning group made up of emergency managers to a more formal network of public and private organizations that spans all five counties and both states.

The REMG is comprised of two committees (1) a technical committee (REMTEC) that is comprised of emergency management professionals, and (2) a policy advisory committee (REMPAC) that includes an elected official from each of the signatory agencies. Over the years since its inception, REMG participation has grown to include representatives from many regional utility providers and a number of local businesses.[43]

## State Programs

### State of Oregon Floodplain and Floodway Removal/Fill Law

The Oregon Removal/Fill Law, which is administered by the Oregon Division of State Lands, requires a permit for activities that would remove or fill 50 cubic yards or more of material in waters of the state (e.g., streams, lakes, wetlands). Beaverton, Clean Water Services and other partner cities must comply with the removal/fill laws when designing and building facilities, and have related responsibilities when dealing with private development and other construction projects.[44]

### Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetlands protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetlands conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

### Oregon Wetlands Joint Venture

The Oregon Wetlands Joint Venture is a coalition of private conservation, waterfowl, fisheries, and agriculture organizations working with government agencies to protect and restore important wetland habitats.[45]

## Federal Programs

### National Weather Service

The National Weather Service provides flood watches, warnings, and informational statements for rivers throughout Washington County.

### National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more that one property.

### Federal Emergency Management Agency (FEMA) Programs

The Federal Emergency Management Agency (FEMA) resulted from the consolidation of five federal agencies that were dealing with different types of emergencies. Since then, many states and local jurisdictions have accepted this approach and changed the names of their organizations to include the words "emergency management." Beaverton is one of those local jurisdictions.[46] FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance.

### National Flood Insurance Program (NFIP)

Flood insurance is available to citizens in communities that adopt and implement NFIP siting and building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, areas subject to inundation during a base flood event, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps that are available through Beaverton. Oregon's Department of Land Conservation and Development is the state's NFIP-coordinating agency. NFIP claims data can be helpful in delineating areas where past losses have occurred, especially where there have been repetitive losses. These areas are particularly problematic and in need of mitigation.

### The Community Rating System (CRS)

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners within the City would receive reduced NFIP flood insurance premiums if the City implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website at http://www.fema.gov/nfip/crs.htm.

The City of Beaverton was designated a CRS Class 9 community in 1990, 1991, and 1992 with the potential for a better class designation. However, budget constraints and staff layoffs in 1993 eliminated the City from further participation, even though the standards adopted by the City go well beyond the minimum required for participation in the NFIP.

## Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Beaverton can undertake to reduce risk and prevent loss from flood events. There are three short-term and six long-term flood hazard action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

**ST-FL#1: Evaluate the requirements for Beaverton to become a participant in the NFIP's Community Rating System (CRS).**

***Ideas for Implementation***

- City officials should review the requirements for CRS participation and assess the steps needed to obtain certification; and
- City officials should consider pursuing certification under the CRS program.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Emergency Management, CDD, Engineering, Operations
**External Partners:** Clean Water Services, Department of Land Conservation and Development, Federal Emergency Management Agency

| | |
|---|---|
| **Timeline:** | 1 year |
| **Plan Goals Addressed:** | Create a Disaster Resistant and Resilient Community |

**ST-FL#2: Analyze each repetitive loss property to identify viable mitigation options.**

***Ideas for Implementation***

- Use insurance claim data from FEMA and OEM to identify properties in the City that have filed more than one National Flood Insurance Program (NFIP) insurance claim. Some properties that have experienced repetitive flood damage may not be enrolled in the NFIP (e.g., properties not in the floodplain, but experiencing damage from urban flooding). Data concerning these properties may be more difficult to obtain;
- Consider identified properties for mitigation activities. Funding for mitigation may be available through FEMA's Hazard Mitigation Grant or Flood Mitigation Assistance programs;
- Prioritize properties for mitigation activities using a benefit/cost analysis; and
- Map and analyze each repetitive loss property to develop appropriate mitigation actions.

| | |
|---|---|
| **Coordinating Organization:** | City of Beaverton |
| **Internal Partners:** | Emergency Management, Community Development, Engineering, Geographic Information System |
| **External Partners:** | Oregon Emergency Management, Department of Land Conservation and Development, Federal Emergency Management Agency, Natural Resources Conservation Service |
| **Timeline:** | Ongoing |
| **Plan Goals Addressed:** | Create a Disaster Resistant and Resilient Community |

**ST-FL#3: Develop mitigation and preparedness measures for critical public infrastructure and facilities located in flood hazard areas.**

Critical facilities fall into two principal categories:

(1) Buildings, bridges, roadways, or locations vital to emergency response efforts; and

(2) Facilities that, if damaged, could cause secondary or compound disasters (e.g., sewer and gas lines).[47]

***Ideas for Implementation***

- Document in database format as well as in maps the critical facilities that are at risk from flood events; and
- Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should flood events cause damages to the facilities in question.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Geographic Information System, Emergency Management
**External Partners:** Overhead Utilities Tualatin Valley Water District, Clean Water Services
**Timeline:** 1-3 years
**Plan Goals Addressed:** Enhance Emergency Services

---

**LT-FL#1: Develop acquisition and management strategies to preserve open space in the floodplain.**

***Ideas for Implementation***

- Develop a comprehensive strategy for acquiring and managing floodplain open space in Beaverton. Perhaps conduct regional-wide funding search, but keep management of program under local jurisdiction;
- Explore funding for open space acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations;
- Develop a regional partnership between flood mitigation organizations;
- Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality; and
- Work with landowners to develop flood management practices that provide healthy fish habitat.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Community Development, Emergency Management
**External Partners:** Clean Water Services, Tualatin River Watershed Council, Metro, FEMA, ODFW, Natural Resources Conservation Service, SWCD
**Timeline:** Ongoing
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

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**LT-FL#2: Provide flood event education and outreach to households and businesses.**

***Ideas for Implementation***

- Identify and map vulnerable populations;
- Create flood education and outreach aimed at specific populations (i.e. schools, households, businesses, etc);
- Identify and provide mitigation guidance to owners of properties at risk from flooding;
- Develop a contact list of households and/or businesses that may have an interest in flood mitigation or flood response issues;

- Recruit individuals to speak to households, and businesses/employees about flood issues;
- Develop a "Clean Stream" sponsorship program, using the "Friends of Fanno Creek" model. Erect signage recognizing individuals, households, businesses, and organizations committed to the ongoing care of a waterway section;
- Integrate a flood hazard component into local watershed education programs;
- Raise awareness level of property owners and developers that impacts upstream result in impacts downstream, and lack of storm water best management practices can result in an increase in flooding events;
- Educate private property owners on restoring natural systems within the floodplain to manage riparian areas and wetlands for flood abatement;
- Erect "monuments" over piped creeks throughout the City and floodplain elevation makers to bring flood awareness to home and business owners who live near them; and
- Educate public on the need for them to maintain their private water quality and water detention facilities.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Geographic Information System, Emergency Management
**External Partners:** Clean Water Services, Tualatin River Watershed Council, Tualatin Riverkeepers, Insurance Information Service of Oregon and Idaho, Washington County, Department of Land Conservation and Development, Oregon Emergency Management
**Timeline:** 18 months
**Plan Goals Addressed:** Improve Partnerships for Communication and Coordination

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**LT-FL#3: Enhance data and mapping for floodplain information within the City.**

### Ideas for Implementation

- Prepare floodplain maps for all local streams not currently mapped on Flood Insurance Rate Maps or County maps. The maps should show the expected frequency of flooding, the level of flooding, and the areas subject to inundation. The maps can be used for planning, risk analysis, and emergency management;
- Maintain maps of covered streams and creeks;
- Identify mapped culverts that historically create flooding problems and target them for retrofitting;
- Prepare an inventory of urban drainage problems;

- Coordinate with local agencies and organizations to obtain flood data and mapping resources;
- Integrate the Capital Improvement Plan process with GIS;
- Include a map layer with arrows to indicate direction of stream/creek flow; and
- Add creek names that are missing and coordinate the naming of unnamed creeks.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Engineering, Operations, Geographic Information System
**External Partners:** Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District
**Timeline:** 1-5 years
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

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**LT-FL#4: Use storm water and urban design best management practices (BMPs).**

*Ideas for Implementation*

- Reduce effective impervious surfaces that contribute to storm water volume being pumped into existing waterways and exceeding their volume capacity;
- Increase storm water infiltration through installation of porous surfaces to reduce storm water volume;
- Support urban land design practices that improve upon existing infiltration systems and provide infiltration of water rather than creating storm water runoff and increasing hydrologic impacts;
- Abide by adopted design and construction standards for the protection of vegetated corridors;
- Incorporate Metro's "green street" design principles and educational publications into the urban design process;
- Continue maintenance on storm water system to increase capacity, and
- Identify and map areas where flood probability/frequency can be economically reduced or eliminated.

**Coordinating Organization** City of Beaverton
**Internal Partner:** Community Development, Engineering
**External Partners:** Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Metro
**Timeline:** 1-5 years
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

**LT-FL#5: Update City code to improve risk reduction and prevention of natural hazard impacts.**

*Ideas for Implementation*

- Remove barriers in City codes and planning regulations that prevent best management practices in urban design;
- Protect critical and essential facilities against flood damage at the time of initial construction;
- Consider increasing regulations for all new fill, grading, and dredging in floodplain areas;
- Regulate to prevent construction of flood barriers which will unnaturally divert flood waters or increase flood hazards;
- Review and update City flood ordinance. Provide additional, more stringent standards designed to encourage sound floodplain management, reduce flood risks, and potentially allow property owners to obtain flood insurance at a lower premium rate;
- Write and implement new code requiring developers to install permeable surfaces to reduce storm water runoff volume and encourage aquifer recharging via increased storm water percolation;
- Consider adopting stricter elevation requirements for development within the floodplain; and
- Develop codes and ordinances to require owners of private water quality and water detention facilities to maintain them so that they can perform their required function and engineered capacity.

| | |
|---|---|
| **Coordinating Organization** | City of Beaverton |
| **Internal Partner:** | Community Development, Engineering |
| **External Partner:** | Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District |
| **Timeline:** | 1-2 years |
| **Plan Goals Addressed:** | Create a Disaster Resistant and Resilient Community |

**LT-FL#6: Create a regional partnership to reduce flood loss across the region.**

*Ideas for Implementation*

- Work flood issues on a regional basis to avoid moving flood problems to other jurisdictions;
- Create a regional process for naming un-named streams; and
- Work with regional partners including the City, Clean Water Services and the State Floodplain Manager to improve floodplain

data for the City that will support conducting future full risk analyses in Beaverton.

| | |
|---|---|
| **Coordinating Organization** | City of Beaverton |
| **Internal Partner:** | Community Development, Engineering, Geographic Information Systems |
| **External Partners:** | Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Washington County, Other Cities |
| **Timeline:** | 1-5 years |
| **Plan Goals Addressed:** | Create a Disaster Resistant and Resilient Community, Improve Partnerships for Communication and Coordination |

# Flood Mitigation Resources

## City Resources

### Emergency Management Program

The City has established an Emergency Management Program consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). It is organized under the auspices of the City Council and works under the overall supervision of the Mayor.

The City has an Emergency Manager who is part of the Mayor's Office and who is responsible for managing the City's program in all four phases of Emergency Management. Responsibilities of the City's Emergency Manager include:

- Development and maintenance of the City's Response, Recovery, Preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies

**Contact**: Emergency Manager, City of Beaverton Emergency Management
**Address**: 20665 SW Blanton St. Aloha, OR, 97007
**Phone**: (503) 642-0383
**Website**: www.ci.beaverton.or.us/departments/emergency/
**Email**: emergmngmail@ci.beaverton.or.us

### Community Development Department

The Community Development Department consists of the Administration, Building, Development Services, GIS and Planning Services Divisions. The functions of the department include Community Planning, administration of the Community Development Code as it relates to Land Development, Building Plan Review and Inspections, and Customer Service.[48]

**Contact**: Director, Community Development Department

**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2493
**Website**: http://www.ci.beaverton.or.us/departments/cdd
**Email**: cddmail@ci.beaverton.or.us

### Engineering Department

The Engineering Department's mission is to provide excellent engineering and construction support services to the citizens and administration of the City of Beaverton in the areas of capital improvements and modifications to the City infrastructure, traffic and transportation and water system operation and maintenance.

**Contact**: Director, Department of Engineering
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2269
**Website**: www.ci.beaverton.or.us/departments/engineering/
**Email**: engmail@ci.beaverton.or.us

### Finance Department

The Information Systems Department (ISD) is part of the Finance Department and includes GIS Services..

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

### Operations and Maintenance Department

The Operations and Maintenance Department is responsible for providing a wide variety of maintenance activities to ensure the long-term integrity of the City's infrastructure. Maintenance activities include: City Landscapes & Trees; Roadways; Pedestrian/Bike Paths; Traffic Signals; Streetlights; Underground Storm Drainage Pipes; Water Quality Facilities; Underground Sanitary Sewer Pipes; City Facilities; City Vehicles & Equipment.

**Contact**: Operations Director
**Address**: 9600 SW Allen Boulevard, Beaverton, OR 97005
**Phone**: (503) 526-2220
**Website**: www.ci.beaverton.or.us/departments/operations/
**Email**: opsmail@ci.beaverton.or.us

## County Resources

### Office of Consolidated Emergency Management (OCEM)

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff.

Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact:** Director, Washington County Emergency Management
**Address:** 20665 SW Blanton St., Aloha, OR, 97007
**Phone:** (503) 642-0371
**Website:** http://www.ocem.org
**Email:** info@ocem.org

### Washington County Department of Land Use and Transportation

The Department of Land Use and Transportation prepares, implements, and enforces the Community Development Code in areas under County jurisdiction. Section 421 of the Community Development Code deals specifically with development in and around floodplains. The County maintains the data and maps that delineate the floodplains and also provides land use maps that identify comprehensive plan designations and zoning for all parcels under County jurisdiction.

**Contact:** Washington County Department of Land Use and Transportation
**Address:** 155 N First Ave. Suite 350, MS 13, Hillsboro, OR 97124
**Phone:** (503) 846-3872
**Fax:** (503) 846-2908
**Website:** http://www.co.washington.or.us/
**Email:** lutdir@co.washington.or.us

### Clean Water Services (CWS)

Clean Water Services (formerly the Unified Sewerage Agency) provides sanitary sewer and storm water management services to the unincorporated urbanized areas of Washington County. CWS works with the County and cities within the County to build and maintain public drainage systems that meet public needs and comply with regulations set by the Oregon Department of Environment Quality. CWS maintains storm sewers and pipelines, open drainage ditches, and stormwater detention ponds; however, inside the City of Beaverton, City crews maintain these facilities. CWS also publishes long-term flood management plans, with a primary focus on the protection of riparian buffer areas and wetland preservation. CWS is slated to complete the Watersheds 2000 project in 2003, an inventory of the location and condition of the stream (surface water) system in the Tualatin Basin.

**Contact:** Clean Water Services
**Address:** 155 N. First Ave. Suite 270, Hillsboro, OR 97124
**Phone:** (503) 846-8621
**Fax:** (503) 846-3525

**Website:** http://www.cleanwaterservices.org/

### Tualatin River Watershed Council

The Tualatin River Watershed Council was initiated in 1993 to provide more coordinated and integrated resource planning for the Tualatin River watershed. Its purpose is to address watershed management issues in the Tualatin Basin and provide a framework for coordination and cooperation among key interests. The Council consists of 19 members representing various stakeholders in the watershed including citizens, local governments, agriculture, business, and industry, environmental groups, forestry, water and sewer districts, neighborhood associations, and educators.[49]

**Contact:** Council Coordinator
**Address**: 1080 SW Baseline Building B, Suite B-2, Hillsboro, OR 97123
**Phone:** (503) 648-3174 ext. 116
**Website:** http://www.trwc.org

### Tualatin Riverkeepers

The Tualatin Riverkeepers provide volunteer-based educational and monitoring programs for the Tualatin River Basin. Programs include van tours, canoe trips, speaking engagements, and river cleanups. They focus on preserving the "biotic integrity" of the river system.

**Contact:** Executive Director
**Address:** 16340 S.W. Beef Bend Rd., Sherwood, OR 97140
**Phone:** (503) 590-5813
**Website:** http://www.teleport.com/~triverk/
**Email:** info@tualatinriverkeepers.org

## Regional Resources

### Metro Regional Government

Metro is the directly elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington counties and 24 cities in the Portland metropolitan area. Chapter 5 of Metro's Regional Framework Plan addresses natural hazards. Metro's Natural Hazards Program is a service of the Growth Management Services Department's Data Resource Center. Their web pages relate to natural hazards that may impact the Portland metropolitan area. Their links provide information about the natural hazards in the Portland metropolitan area and suggest tools for reducing potential damages before disaster strikes. Metro produced the *Regional Hazard Mitigation Policy and Planning Guide* in 1999 to assist local governments in planning for future natural hazard events.

**Contact 1:** Metro Regional Government
**Address:** 600 NE Grand Ave, Portland, OR 97232-2736
**Phone:** (503) 797-1839
**Fax:** (503) 797-1911
**Website:** http://www.metro.dst.or.us/metro/growth/gms.html
**Email:** 2040@metro-region.org

**Contact 2:** Metro Data Resource Center
**Website:** http://storefront.metro.dst.or.us/drc/nathaz/nathaz.cfm
**Email:** drc@metro.dst.or.us

## State Resources

### Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to natural hazards, with flood as its major focus. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance such as conducting workshops, reviewing local land use plan amendments, and working interactively with other agencies.

**Contact:** Natural Hazards Program Manager, DLCD
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html
**Oregon Floodplain Coordinator**: (503) 373-0050 ext. 255

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

OEM administers FEMA's Hazard Mitigation Grant Program, which provides post-disaster monies for acquisition, elevation, relocation, and demolition of structures located in the floodplain. OEM also administers FEMA's Flood Mitigation Assistance Program. This program provides assistance for NFIP insured structures only. OEM also helps local jurisdictions to develop hazard mitigation plans. OEM is heavily involved in flood damage assessment and works mainly with disaster recovery and hazard mitigation programs. OEM provides training for local governments through workshops on recovery and mitigation. OEM also helps implement and manage federal disaster recovery programs.

**Contact:** Office of Emergency Management
**Address:** 595 Cottage Street NE, Salem, OR 97310
**Phone:** (503) 378-2911
**Fax:** (503) 588-1378
**Website:** http://www.osp.state.or.us/oem/
**OEM Hazard Mitigation Officer:** (503) 378-2911 ext. 247
**Recovery and Mitigation Specialist:** (503) 378-2911 ext. 240

### Oregon Department of Fish and Wildlife (ODFW)

ODFW's mission is to protect and enhance Oregon 's fish and wildlife and their habitats for use and enjoyment by present and future generations. ODFW regulates stream activity and engages in stream enhancement activities.

**Contact:** ODFW
**Address:** 2501 SW First Avenue, PO Box 59, Portland, OR 97207
**Phone:** (503) 872-5268
**Website:** http://www.dfw.state.or.us/
**Email:** Odfw.Info@state.or.us

### Oregon Division of State Lands (DSL)

DSL is a regulatory agency, responsible for administration of Oregon's Removal-Fill Law. This law is intended to protect, conserve, and make the best use of the state's water resources. It generally requires a permit from DSL to remove, fill, or alter more than 50 cubic yards of material within the bed or banks of waters of the state. Exceptions are in state scenic waterways and areas designated essential salmon habitat, where a permit is required for all in-stream activity, regardless of size. DSL and the US Army Corps of Engineers may issue these permits jointly.

**Contact:** Division of State Lands
**Address:** 775 Summer Street NE, Suite 100, Salem, OR 97301-1279
**Phone:** (503) 378-3805
**Fax:** (503) 378-4844
**Website:** http://statelands.dsl.state.or.us/
**Assistant Director:** (503) 378-3805, ext. 279
**Western Region Manager:** (503) 378-3805, ext. 244

### Oregon Water Resources Department (WRD)

The WRD's mission is to serve the public by practicing and promoting wise long-term water management. The WRD provides services through 19 watermaster offices throughout the state. In addition, five regional offices provide services based on geographic regions. The Department's main administration is performed from the central office in Salem.

**Contact:** WRD
**Address**: 158 12th ST. NE, Salem, OR 97301-4172
**Phone:** (503) 378-8455
**Website:** http://www.wrd.state.or.us/index.shtml
http://www.co.washington.or.us/dptmts/wtr_mstr/wtr_mstr.htm

## Federal Resources

### Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission is "to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

**Contact:** FEMA, Federal Regional Center, Region 10
**Address:** 228th St. SW, Bothell, WA 98021-9796
**Phone:** (425) 487-4678
**Website:** http://www.fema.gov

**To obtain FEMA publications:**
**Phone:** (800) 480-2520

**To obtain FEMA maps:**
**Contact:** Map Service Center
**Address:** P.O. Box 1038, Jessup, Maryland 20794-1038
**Phone:** (800) 358-9616
**Fax:** (800) 358-9620

### United States Geological Survey (USGS)

The USGS website provides current stream flow conditions at USGS gauging stations in Oregon and throughout the Pacific Northwest. The Oregon USGS office is responsible for water-resources investigations for Oregon and part of southern Washington. Their office cooperates with more than 40 local, state, and federal agencies in Oregon. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies.

**Contact:** USGS Oregon District Office
**Address:** 10615 S.E. Cherry Blossom Dr., Portland, OR 97216
**Phone:** (503) 251-3200
**Fax:** (503) 251-3470
**Website:** http://oregon.usgs.gov
**Email:** info-or@usgs.gov

### Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. The Bureau of Reclamation owns Scoggins Dam in Washington County and prepares emergency action plans for events at the dam.

**Contact:** Bureau of Reclamation, Pacific Northwest Region
**Address:** 1150 N. Curtis Road, Boise, ID 83706
**Phone:** (208) 378-5012
**Website:** http://www.pn.usbr.gov/contact/index.shtml

### Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. In Oregon, joint permits may be issued with the Division of State Lands. The Corps is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation.

**Contact:** US Army Corps of Engineers-Portland District, Floodplain Information Branch
**Address:** P.O. Box 2946, Portland, OR 97208-2946
**Phone:** (503) 808-4874
**Fax:** (503) 808-4875
**Website:** http://www.nwp.usace.army.mil/

### National Weather Service, Portland Bureau

The National Weather Service provides flood watches, warnings, and informational statements for rivers in Washington County. The majority of the County falls in the NWS "Willamette Tributary" region. The far western and northwestern portions of the County fall in the "SW Washington/NW Oregon" region. The NWS Portland office provides river level information online and by phone.

**Contact:** National Weather Service, Portland Bureau
**Address:** P.O. Box 2946, Portland, OR 97208-2946
**Phone**: (503) 261-9246 or (503) 261-9247
**Fax**: (503) 808-4875
**Website**: http://www.wrh.noaa.gov/Portland/public_hydro/

### Washington County Soil and Water Conservation District (SWCD)

The SWCD works in partnership with the Natural Resource Conservation Service to promote soil and water conservation in Washington County. SWCD works with agricultural interests and landowners to provide information on natural resource conservation practices. The partnership blends individual member resources to offer technical and financial assistance in planning and applying natural resource conservation practices and systems. Areas of focus include: erosion management, wetlands preservation and restoration, resource inventories, watershed assessments, and conservation education.

**Contact:** Washington County Soil and Water Conservation District
**Address**: 1080 SW Baseline Building B, Suite B-2, Hillsboro, OR 97123
**Phone:** (503) 681-0953
**Fax:** (503) 640-1332
**Website:** http://www.swcd.net/

### National Resources Conservation Service (NRCS), US Department of Agriculture (USDA)

NRCS provides a suite of federal programs designed to assist state and local governments, and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance for clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under the EWP must be environmentally and economically sound and generally benefit more that one property.

**Contact**: USDA-NRCS
**Address**: 1080 SW Baseline, Bldg B, Suite B-2, Hillsboro 97123-3823
**Phone**: (503) 648-3174
**Fax**: (503) 640-1332
**Website**: http://www.swcd.net/

## Additional Resources

### *The National Flood Insurance Program*

The National Flood Insurance Program (NFIP) Website is a subsection of the Federal Emergency Management Agency (FEMA) site (http://www.fema.gov). The NFIP information is intended for both the general public and the many organizations and agencies participating in the program. It includes information about the NFIP and other flood disaster assistance available from the Federal Government. It also provides access to the newly revised NFIP booklet: *Answers to Questions about the National Flood Insurance Program*.

**Contact:** The National Flood Insurance Program
**Phone:** (888) FLOOD29 or (800) 427-5593
**Website:** http://www.fema.gov/nfip

### The Association of State Floodplain Managers

The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The Development Services Engineer for the City of Beaverton is a member of ASFPM. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.

**Contact:** The Association of State Floodplain Managers
**Address:** 2809 Fish Hatchery Road, Madison, WI 53713
**Phone:** (608) 274-0123
**Website:** http://www.floods.org

### USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data; numerous fact sheets and other publications; various technical resources; descriptions of ongoing water survey programs; local water information; and connections to other sources of water information.

**Contact:** USGS Water Resources
**Phone:** (503) 251-3200
**Website:** http://water.usgs.gov or http://water.usgs.gov/public/realtime.html
**Email**: info-or@usgs.gov

### Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

**Contact:** Office of Hydrology, National Weather Service
**Website:** http://www.nws.noaa.gov/oh or http://www.nws.noaa.gov/oh/hic/

### The Floodplain Management Association

The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues (with hypertext links if available), a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and, of course, a copious catalog of Web links.

**Contact:** Floodplain Managers Association
**Website:** http://www.floodplain.org
**Email**: admin@floodplain.org

### Northwest Regional Floodplain Managers Association (NORFMA)

This site is a resource for floodplains, fisheries, and river engineering information for the Northwest. This site provides technical information, articles, and Internet links in the field of floodplain and fisheries management
.

**Contact:** Northwest Regional Floodplain Managers Association
**Website:** http://www.norfma.org/

### FEMA's List of Flood Related Websites

This site contains a long list of flood related Internet sites from "American Heritage Rivers" to "The Weather Channel," and is a good starting point for flood information on the Internet.

**Contact:** Federal Emergency Management Agency.
**Phone:** (800) 480-2520
**Website:** http://www.fema.gov/nfip/related.htm

## Publications

*Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can also write, call, or fax to obtain this document:

**Contact:** Natural Hazards Program Manager, Department of Land Conservation and Development
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

*NFIP Community Rating System Coordinator's Manual*. FEMA/NFIP. Indianapolis, IN.

This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system, and what activities communities can pursue to earn points. These points then add up to the "rating" for the community, and flood insurance premium discounts are calculated based upon that "rating." The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.

**Contact:** NFIP Community Rating System
**Phone:** (800) 480-2520 or (317) 848-2898
**Website:** http://www.fema.gov/nfip/crs.htm

*Floodplain Management: A Local Floodplain Administrator's Guide to the NFIP*. FEMA-Region 10. Bothell, WA.

This document discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies, as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.

**Contact:** National Flood Insurance Program
**Phone:** (800) 480-2520
**Website:** http://www.fema.gov/nfip/

*Flood Hazard Mitigation Planning: A Community Guide*, (June 1997), Massachusetts Department of Environmental Management.

This informative guide offers a ten-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

**Contact:** Massachusetts Flood Hazard Management Program
**Phone:** (617) 626-1250
**Website:** http://www.magnet.state.ma.us/dem/programs/mitigate

*Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials*, (February 1987), FEMA-116.

This guidebook offers a table on actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.

**Contact:** Federal Emergency Management Agency
**Phone:** (800) 480-2520
**Website:** http://www.fema.gov

*Oregon Model Flood Damage Prevention Ordinance*, (January 1999), FEMA/DLCD.

This is an example of how to write an ordinance that complies with NFIP/FEMA standards. Communities can simply adopt this ordinance, word for word, filling in the blanks specific to their community or jurisdiction.

**Contact:** Department of Land Conservation and Development
**Phone:** (503) 373-0050
**Website:** http://www.lcd.state.or.us/hazards.html

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## Flood Endnotes

[1] The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, June 2000).

[2] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[3] Ibid.

[4] Washington County Watermaster, Gauging Station Selection, http://www.co.washington.or.us/deptmts/wtr_mstr/stationselect.cfm

[5] The NFIP flood loss data here includes the total assessed damage to building and contents. This does not include the total amount paid to policyholders but rather the assessed values.

[6] Oregon Climate Services (2003).

[7] Ibid.

[8] Ibid.

[9] Beaverton Code 9.05.015 – *Site Development Ordinance, Definitions*

[10] Ibid.

[11] Federal Emergency Management Agency. (June 2003). http://www.fema.gov/fhm/fq_term.shtm#frequt4

[12] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[13] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[14] Beaverton Code, 9.05.60 - P*ermit Issuance or Denial - Floodplain District*

[15] Ibid.

[16] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[17] *Floodplain Management: a Local Administrator's Guide to the National Flood Insurance Program*. FEMA, Region 10.

[18] Ibid.

[19] Ibid.

[20] February 1996 *Flooding and Landslides and Stream Erosion in the State of Oregon*. The Interagency Hazards Mitigation Team (1996) Oregon State Police – Office of Emergency Management.

[21] February 1996 *Flooding and Landslides and Stream Erosion in the State of Oregon*. The Interagency Hazards Mitigation Team (1996) Oregon State Police – Office of Emergency Management.

[22] Ibid.

[23] Ibid.

[24] Washington County Ordinance 421-1.3, *Floodplain Drainage Area Hazard Development Standards*.

[25] February 1996 *Flooding and Landslides and Stream Erosion in the State of Oregon*. The Interagency Hazards Mitigation Team (1996) Oregon State Police – Office of Emergency Management.

[26] Ibid.

[27] Ibid.

[28] Personal Interview, Ed McMahon. June 24, 2003

[29] Ibid.

[30] Beaverton Code, 9.05.85 - P*ermit Issuance or Denial - Floodplain District, General Standards*

[31] Ibid.

[32] Ibid.

[33] Ibid.

[34] *Regional Hazard Mitigation Policy and Planning Guide*. (June 1999). Metro Regional Government.

[35] Personal Interview. Fishbeck, Dale. March 3, 2001.

[36] Tualatin River Watershed Council, http://www.trwc.org/ (February 2001).

[37] *Department of State Lands, Wetlands Functions and Assessment*, Website: http://statelands.dsl.state.or.us/fact5.pdf (May 2001)

[38] Ibid.

[39] Title 3, Metro Regional Framework Plan, www.multnomah.lib.or.us/metro/growth/tfplan/funcsum.html (July 2001).

[40] The data used to create these files were; Beaverton Zoning current as of July 2003, Beaverton City Limits current as of July 2003, Beaverton Building footprints current as of March 2001, Metro Floodplain current as of June 2002

The taxlot base does not have positional accuracy, and the Metro Floodplain may be outdated. The building footprints are positionally accurate but not up to date, as there has been buildings added and removed since the file was created. All these things have to be taken into consideration.

For the analysis - taxlots with a zone description of (CV, OC, NS, CS, TC-SR and GC) to create the Commercial category. All taxlots with a zone description of (CI, IP and LI) to create the Industrial category. All taxlots with a zone description of (R10, R7, R5 and R4) to create the Single Family Residential category. All taxlots with a zone description of (R3.5, R2 and R1) to create the Multi Family Residential category.

Clip Commercial (then Industrial...) with Floodplain. Intersect this with Planimetric Building Footprints. Calculate table statistics. Number of properties = Count field. For more information on this analysis contact Doug Taylor in Beaverton's GIS Department.

[41] Personal Interview. Smith, Kendra. February 21, 2001.
[42] Ibid.
[43] http://www.ci.beaverton.or.us/departments/emergency/

[44] *Surface Water Management Framework*. (January 2001). Clean Water Services (formerly Unified Sewerage Agency.)
[45] Oregon Wetlands Joint Venture, Website: http://www.dfw.state.or.us/ODFwhtml/Wetlands/about.htm (May 2001).
[46] www.ci.beaverton.or.us/departments/emergency/emergency_whatis.html

[47] *Regional Hazard Mitigation Policy and Planning Guide*. (June 1999). Metro Regional Government.

[48] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/cdd, (Accessed 5/2/03) (Entire Paragraph)

[49] Community Watershed Stewardship Program, Website: www.upa.pdx.edu/CWSP/WATSHED/ (May 2001).

# Chapter 8
# Severe Weather Events

# Table of Contents

This chapter is concerned with severe weather events and focuses on severe winter storms and windstorms. Flooding is not included in this chapter, as it has been covered separately in Chapter 7.

# Why is Severe Weather a Threat to Beaverton?

Severe weather events pose a significant threat to life, property, and the local economy in Beaverton by creating conditions that disrupt essential regional services such as public utilities, telecommunications, and transportation routes. Such storms can produce rain, freezing rain, ice, snow, cold temperatures, and high winds. High winds, especially when accompanies by ice storms, can destroy trees and power lines, potentially interrupting utility services. A windstorm in 1995 damaged numerous homes, businesses, and public facilities, and generated tons of disaster-related debris. Washington County sought and received a Presidential Disaster Declaration to recover from the event.

# Historical Severe Winter and Windstorm Events

## Regional Severe Weather Events

Destructive storms, producing heavy snow, ice, and high winds have occurred throughout Northwestern Oregon's history. The region's largest winter storms occurred in 1937 and 1950, while the most destructive windstorm occurred in 1962.

The Columbus Day storm in 1962 was the most destructive windstorm ever recorded in Oregon, in terms of both loss of life and property damage.[1] Damage was the most severe in the Willamette Valley.[2] The storm killed thirty-eight people and caused over $200 million in damage. Hundreds of thousands of homes were without power for short periods, while others were without power for two to three weeks. The storm left more than 50,000 homes damaged, and nearly 100 destroyed. Entire fruit and nut orchards were destroyed and livestock killed as barns collapsed and trees blew over. Intense wind speeds were recorded in the metropolitan areas with gusts of 116 mph on the Portland Morrison Bridge and 90 mph peak gusts in Hillsboro.

While relatively rare, tornados can and do occur in the Portland metropolitan area. A small, short-lived tornado near Forest Grove in June 1966 moved from the southwest to northwest through a corn field and prune orchard, uprooting 20 to 25 prune trees. The tornado occurred during the late afternoon, had a path length of one-fourth mile and was 60 yards in width at the widest point. There was no other significant damage reported with the tornado. Heavy rain occurred at the same time, but no hail or lightning was reported.[3]

Three back-to-back storms in January 1950 severely affected infrastructure, residents, and businesses across the state. Deep snow drifts closed all highways west of the Cascades and through the Columbia River Gorge. Sleet that turned to freezing rain caused unsafe conditions on highways and damaged trees and power lines. During a severe sleet event on January 18, hundreds of motorists were stranded in the Columbia River Gorge. Freezing rain downed many trees and power lines, creating widespread power outages across northwestern Oregon. Hundreds of thousands of dollars in damage to public and private property occurred. Hillsboro reported 42.4 inches of snowfall during this event. [4]

A serious storm in February 1937 resulted in the death of five people in the Portland area. Record snowfalls in Portland created snowdrifts up to 25 feet in height, and a low temperature of 17 degrees Fahrenheit. Schools and businesses were closed and flood damage was reported in downtown Portland basements as the snow melted.[5] All major highways were closed, shutting off the main transportation arteries for travel and business.

A December 1919 snowstorm was the third heaviest snowfall-producing storm to hit Oregon on record. The Columbia River froze over, closing the river to navigation from the confluence with the Willamette River upstream. The snowstorm affected nearly every part of the state, with heavy snow falling over a widespread area. [6]

A six-day storm in January 1909 brought many locations more snow than is normally accumulated in an entire year. [7]

Between December 20 and 23, 1892, substantial snow fell across most of northern Oregon, with the greatest snowfall reported over northwestern Oregon, where storm totals ranged from 15 to 30 inches. [8]

## City Severe Weather Storms

Historically, Beaverton has been affected by severe weather including, snow, ice, and high winds. Much the same as the rest of the state of Oregon, Beaverton has suffered significant loses over the years in property damage and loss of life from these storms.[9]

The Columbus Day Storm of 1962 brought extensive damage to Beaverton, as it did to the rest of the state. During the storm, School District 48 (which includes Beaverton) suffered damage totaling approximately $194,600, in 1962 dollars. The storm significantly damaged many other structures throughout the City and caused multiple injuries.

Another storm impacted Beaverton on October 2, 1967. Again, this storm caused significant damage in the city due to high winds, much like the Columbus Day Storm. Many of the same victims of the Columbus Day Storm were once again affected by the 1967 storm. Front windows at Jennie's Yardstick on Canyon Road blew out at about 9:20 p.m., convincing Owner Robert Well that "lightning can strike twice."[10] Possibly hardest hit in the Beaverton area was Grace Brethren Church at NW 180th Avenue and Walker Road, which sustained an estimated $4,000 to $5,000 in wind damage when a newly-roofed south gable blew off.[11] One portion of the roof, weighing approximately 300 pounds, was hurled over the north side of the church and landed 150 feet from the building.[12]

In January 1969 one of the fiercest winter storms in recent history occurred causing heavy icing on Beaverton streets and sidewalks. Canyon Road closed briefly as the storm continued through the end of January. As the movement of traffic in and out of the Portland Metro area was severely limited, livestock shipments were delayed, causing beef to become unavailable in stores for a short period. The storm was also responsible for one death.[13]

In early January 1979 severe winter storm struck, causing the closure of several schools and business due to broken pipes. Pipes also ruptured in several homes throughout Beaverton. A 1,500 gallon oil truck lost control on icy roads, spilling its entire contents. The storm's freezing rain lead to several minor accidents throughout Beaverton.[14] Later in mid-January 1979, 10,000 Washington County residents lost power due to broken limbs and downed trees brought down by freezing rain. An ice generated electrical short led to a fire causing $35,000 in damages to one Beaverton home.[15]

In early January of 1980 a snowstorm hit Beaverton, and several businesses reported a sharp drop in business due to traffic difficulties.[16]

A severe wind storm in November of 1981 brought yet another reminder to Beaverton's residents of the damage high winds can bring. The winds, which reminded many of the Columbus Day Storm of 1962, left two Washington County men dead, thousands of homes temporarily without power, and many yards and buildings damaged by falling trees.[17] The storm caused damage to infrastructure as well, including the two-million-gallon water tank on Cooper Mountain.[18]

In February 1989 and December 1990, severe storms caused school closings, accidents, and widespread incidence of broken pipes and downed power lines. Approximately 14,000 residents of Beaverton lost power in February 1989.[19] A section of Highway 217 closed briefly due to the hazardous conditions caused by the storm of December 1990.[20]

A more recent storm in December 1995 caused Beaverton to be one of the hardest hit communities in the Portland-Metro area. Locally, gusts topped 60 mph and exceeded 100 mph on the Oregon Coast.[21] The winds caused a high risk to residents in the area. Emergency officials reported more than 40 injuries associated with the storm.[22]

The last severe freeze that affected the City occurred in December 1998. This freeze significantly affected the Tualatin Valley Water District water system by causing multiple breaks in the mainline water system.

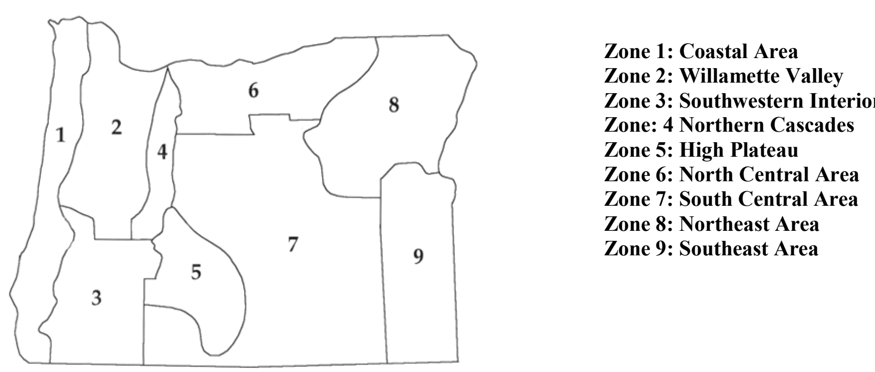
## Characteristics of Severe Winter and Windstorms in Beaverton

### Weather patterns

Severe storms affecting Beaverton with snow and ice typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from October through March.[23] A majority of the destructive surface winds in Oregon and, specifically, Beaverton, are from the southwest.[24] Some winds blow from the east, but most often do not carry the same destructive force as those from the Pacific Ocean.

Beaverton's average rainfall is approximately 39.4 inches a year.[25] The National Climatic Data Center has established climate zones in the US for areas that have similar temperature and precipitation characteristics. Oregon's latitude, topography, and proximity to the Pacific Ocean give the state diversified climates. Beaverton is in Zone 2 as seen in Figure 8-1. The climate in Zone 2, including Beaverton and surrounding areas, generally consists of wet winters and dry summers. In 2001, 89 percent of the precipitation occurred between October and May; eleven percent of the annual rainfall occurred between June and September, and four percent occurred in July and August.[26] There is an average of only five days per year of measurable snow with snowfall accumulations rarely measuring more than two inches.[27]

#### Figure 8-1. Oregon Climate Zones




Source: Taylor, George H. and Hannan, Chris, *The Oregon Weather Book*, OSU Press (1999)

### Snow

While snow is relatively rare in western Oregon, the Columbia Gorge provides a low-level passage through the mountains. Cold air, which lies east of the Cascades, often moves westward through the Gorge, and funnels cold air into the Portland Area. If a wet Pacific storm happens to reach the area at the same time, larger than average snow events may result.[28]

An example of this type of snowstorm is the previously described storm of January 1980, when strong storms, accompanied by snow, ice, wind, and freezing rain hit Oregon statewide. Impacts in the Portland area alone included 200,000 customers without power or phone service for several days. Over 100 boats, with a combined value of over $3 million dollars, sunk in the Gorge and Portland, resulting in one fatality.

### Ice

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia Gorge.[29] Like snow storms, ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation, including freezing rain, sleet, and hail.[30]

Freezing rain can be the most damaging of ice formations. While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. As described earlier, ice buildup can bring down trees, communication towers, and wires creating hazards for property owners, motorists, and pedestrians alike. The most common freezing rain problems occur near the Columbia Gorge. As noted above, the Gorge is the most significant east-west air passage through the Cascades. Rain arriving from the west can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.[31]

### Wind

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Most of the winds that come from the west are subdued by the time they reach the Beaverton area because of the influence of the Coast Range. The most destructive winds are those which blow from the south, parallel to the major mountain ranges.[32] Windstorms affect areas of Beaverton with significant tree stands, as well as areas with exposed property, major infrastructure, and above ground utility lines. The lower wind speeds typical in the lower valleys are still high enough to knock down trees, bring down power lines, and cause other property damage. The Columbus Day Storm of 1962 was a classic example of a south windstorm. The storm developed well off the coast of California and moved from the southwest, then turned and came directly from the south toward the Oregon Coast. Atmospheric pressure fell rapidly ahead of the storm center and rose rapidly once the storm center passed, creating very tight and sharp pressure gradients. When the strong surface winds are further reinforced by upper airflow in the same direction, as was the case in the Columbus Day Storm, the surface wind speed is enhanced.[33]

## Severe Weather Community Issues

### Life and Property

Severe weather can be a deceptive killer. Storms, which bring snow, ice, and high winds, can have a significant impact on life and property.

Many severe winter storm deaths occur as a result of traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold. Debris carried along by extreme winds can contribute directly to loss of life and indirectly through the failure of protective structures (i.e., buildings) and infrastructure.

Property is at risk due to flooding (see Chapter 7) and landslides (see Chapter 9) resulting from heavy snowmelt. Additionally, ice, wind, and snow can affect the stability of trees, power lines, telephone lines, and television and radio antennas. Falling trees and limbs affected by these events and saturated soils can become hazards for houses, cars, utilities and other property. These conditions can be major hindrances to emergency response and disaster recovery.

Windstorms have the ability to cause damage over 100 miles from the center of storm activity. Wind pressure can create a direct frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. The forces applied by the wind to the building's protective envelope (doors, windows, and walls) can cause the failure of some of the building's components resulting in considerable structural damage. The effects of wind speed are shown in Table 8.1.

### Table 8.1 Effect of Wind Speed

| WIND SPEED (MPH) | WIND EFFECTS |
|---|---|
| 25-31 | Large branches will be in motion. |
| 32-38 | Whole trees in motion; inconvenience felt walking against the wind. |
| 39-54 | Twigs and small branches may break off of trees; wind generally impedes progress when walking; high profile vehicles such as trucks and motor homes may be difficult to control. |
| 55-74 | Potential damage to TV antennas; may push over shallow rooted trees especially if the soil is saturated. |
| 75-95 | Potential for minimal structural damage, particularly to unanchored mobile homes; power lines, signs, and tree branches may be blown down. |
| 96-110 | Moderate structural damage to walls, roofs and windows; large signs and tree branches blown down; moving vehicles pushed off roads. |
| 111-130 | Extensive structural damage to walls, roofs, and windows; trees blown down; mobile homes may be destroyed. |
| 131-155 | Extreme damage to structures and roofs; trees uprooted or snapped. |
| Greater than 155 | Catastrophic damage; structures destroyed. |

Source: Washington County Office of Consolidated Emergency Management

## Infrastructure

### Traffic

Severe weather can cause prolonged and extreme traffic disruptions. The importance of transportation is never more noticeable than in situations where travel is difficult or dangerous. Both property damage and loss of life are risks to those who must drive. Additionally, traffic delays or blockages can seriously hinder the ability of emergency service providers.

Economic concerns rise during storms that cause dangerous road conditions, since many people choose to stay home in these situations. During the 1980 storm, several business owners reported a severe drop in sales. Increased traffic loads on Beaverton streets and highways due to development will add to the potential risk of accidents during severe weather events.[34] To address these concerns, Beaverton has participated in the designation of emergency transportation routes with Washington, Multnomah, Clackamas, and Columbia Counties in

Oregon, as well as Clark County in Washington State. These emergency transportation routes will receive high priority for assessment, clearance, and restoration following a natural hazard event. These routes will be used to move personnel and supplies throughout the region and to bring in support from outside the area.

### Utilities

Historically, falling trees have been the major cause of power outages resulting in interruption of services and damaged property. The issue of weather related power outages should be addressed, since many Beaverton residents rely on electricity for heat. Even homes using natural gas typically require electricity for the system to operate, to run the circulation fans and thermostats. Natural gas distribution systems also rely to some degree on electrical service to keep the system operational and widespread power outages, can interrupt that service. Additionally, when severe weather causes problems with phone lines, it becomes difficult for utility providers to receive and respond to reports of outages and service problems in a timely manner.[35]

Power loss is also a concern economically, since businesses may have to close during power outages. About 78% of Beaverton business owners indicated that loss of electricity would have a serious or moderate impact on their business, while 92.4% of them indicated that electricity was critical or very important to their business (see Appendix D).

Many overhead wires are at risk from snow and ice accumulations that are beyond the design specifications. High winds can create flying debris and down utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Some utility lines could be placed underground, but the expense of such projects can be prohibitive.[36] In terms of energy production, Beaverton does not produce any electric power or have any electric generating facilities itself.[37] Instead, the City has a series of substations and distribution stations. These stations are also susceptible to damage from severe weather events.

Increasing population and new infrastructure in the city means that more lives and property are exposed to risk; this situation creates a higher probability that damage will occur from severe weather events.

### Water Lines

The most frequent water system problem related to cold weather are breaks in the service lines. Breaks frequently occur during severe freeze events, as well as during extreme cooling periods during the months of October, November, and December. In almost every severe winter storm described earlier, broken pipes led to the closures of schools and business throughout Beaverton. The last severe freeze that affected the area occurred in December of 1998. Over a period of nine days, the water systems in Washington County experienced several mainline breaks. The most extensive damage occurred in Tualatin Valley Water District water system, which resulted from a 10-inch main break near the intersection of SW 185th and the Tualatin Valley Highway. The break resulted in temporary loss of service to several houses, including some within the city and approximately $60,000 in street and pipe repairs.

Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property. During the December 1998 freeze, local fire agencies were kept busy for days responding to waterline breaks and assisting homeowners and businesses with water removal.

### Tree Failure and Resulting Power Line Outages

According to Portland General Electric (PGE), trees are the leading cause of storm-related power outages in PGE's service area.[38] Tables 8.2 and 8.3 are Tree Failure Profiles developed by PGE for two of the most common tree failures in the PGE service territory. The profiles are developed from the data collected and used by PGE foresters in targeting "at-risk" trees during routine vegetation maintenance cycles.

**Table 8.2. Tree Failure Profile - Species: Douglas fir** *(Psuedotsuga menziesii)*

| Failed Part | Description of failure/ Tree characteristics | Associated defects/ Indicators | Environment | Management History |
|---|---|---|---|---|
| **BRANCH**<br><br>Frequency:<br><br>High | Small dia. branches from mature trees; can sail up to 75 ft & wrap lines. Overhanging branch failure from snow/ice loading. | Evidence of previous branch failures. | Exposure to winds/gusts greater than 40 mph. Line downwind. | Side trimmed trees. |
| **TRUNK**<br><br>Frequency:<br><br>Low | Failure of multiple tops. | Old topping cut, previous break, decay present. | Wind or ice storms. | Previous topping. |
| | Interior trees, 3-8" dia. | Intermediate/suppressed trees. | Wind, snow/ice loading, recent exposure. | Thinning of stand, exposure as edge tree. |
| | Dead tree of any size in close proximity to line. | Entire tree dead for some time. | Line downwind. | |
| **ROOT**<br><br>Frequency:<br><br>High | Trees of all ages. | Evidence of other root failures. | Slight to moderate wind. | Site disturbance; leave trees from logging or development. |
| | Small, interior trees. | Poor taper, low live crown ratio, aggravating site characteristics. | Slight to moderate wind. | Thinning of stand; overstocked, unmanaged stands. |

Source: Portland General Electric, Forester's Office, 2001; © Portland General Electric Co.

**Table 8.3. Tree Failure Profile - Species: Bigleaf Maple** *(Acer macrophyllum)*

| Failed Part | Description of failure/ Tree characteristics | Associated defects/ Indicators | Environment | Management History |
|---|---|---|---|---|
| ~~BRANCH~~ Frequency: High | Mature trees; scaffold branches; or during full leaf - out. | Decay present at multiple branch attachment. Co-dominant stems with included bark. | Heavy rains after leaf-out in spring; heavy fall rains. Exposure to winds/gusts greater than 30 mph. Line downwind, ivy covered. | Natural and previously pruned; history of side trimming. |
| ~~TRUNK~~ Frequency: Low | Trunk failure at base of tree up to 12 feet. | Decay present in trunk or at base. | On a slope, line downwind, or ivy covered. | In unmanaged or natural areas. |

Source: Portland General Electric, Forester's Office, 2001; © Portland General Electric Co.

# Severe Weather Hazard Assessment

## Severe Weather Hazard Identification

Severe weather is generally a prolonged event involving snow, ice, or wind. The characteristics of severe weather are determined by a number of meteorological factors including the amount and extent of snow or ice, air temperature, wind speed, and event duration. The severe weather events that affect the city typically come from the northwest, the southeast, and through the Columbia River Gorge.

Precipitation, an additional element of severe weather, is measured in addition to wind speed by gauging stations located in Hillsboro and Forest Grove. The National Weather Service, Portland Bureau monitors the stations and provides public warnings on storm, snow, ice, and wind events as appropriate. The Oregon Climate Service collects precipitation data at one station in Beaverton.

New areas of development are often more at risk from natural hazards. New homes and development are pushed into hazard prone areas and new "development leaves some stands of trees vulnerable to 'windthrow' by removing the edges of the stand."[39]

## Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through severe weather identification with an inventory of the existing development exposed to this hazard, assisting in the prediction of how different types of property and population groups will be affected by a hazard.[40] Data including the areas exposed to severe weather in Beaverton can be used to assess the population and total value of property at risk from severe storms.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for Beaverton severe weather storm events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Severe weather can cause power outages and transportation and economic disruptions, and pose a high risk for injuries and loss of life. The events can also be typified by a need to shelter and care for adversely impacted individuals. Beaverton has suffered severe weather in the past that brought economic hardship and affected the life safety of City residents. Future severe weather events may cause similar impacts citywide.

### Risk Analysis

Risk analysis is the third, and most advanced phase of a hazard assessment. It is conducted by use of mathematical models and relies on information compiled during hazard identification and vulnerability assessments. Factors included in assessing severe weather risk include population and property distribution in the hazard area, the frequency of severe weather storm events, and information on tree type, failure rates most susceptible to storm events, utilities, and infrastructure that may be impacted by severe weather. When sufficient data is collected for hazard identification and vulnerability assessment, a risk analysis can be completed. Insufficient data currently exists to complete a risk analysis.

## Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Partnerships for Communication and Coordination
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

### Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, federal agencies, utilities or other organizations

## City Programs

### Capital Improvement Plan

The City of Beaverton's Capital Improvements Plan (CIP) is a dynamic document that lists and prioritizes needed improvements and expansions of the City's infrastructure system to maintain adequate service levels to existing City residents and businesses, and to accommodate population growth and land development. The CIP reflects the needs and priorities established by the City and the resources available to the City. The CIP can be modified during the fiscal year (through the supplemental budget process) as needs, priorities, and resources change. The CIP can assist the City of Beaverton in mitigating against severe weather events by improving infrastructure most prone to damage.

### Emergency Operation Center (EOC)

The Emergency Operations Center is an established location/facility in which City staff and officials can receive information pertaining to an incident and from which they can provide direction, coordination, and support to emergency operations. City personnel who are assigned to and trained for specific positions within the EOC organizational structure staff the EOC. The structure is based on the National Interagency Incident Command System (ICS). The EOC staff provides information and recommendations to the Mayor, through the Incident Commander or as directed, to develop a course of action to respond to and contain, control, and recover from an emergency. Some of the primary functions that are performed at the EOC include: coordination, operations management, planning, information tracking and dissemination, logistical support, financial management and support, and emergency public information.[41]

### Emergency Response and Recovery Plan (ERRP)

The Emergency Response and Recovery Plan (ERRP) describes the roles and responsibilities of the departments and personnel for the City of Beaverton during major emergencies or disasters.

The Plan sets forth a strategy and operating guidelines using the National Interagency Incident Management System's ICS adopted by the City for managing its response and recovery activities during disasters and emergencies.

The ERRP's development and maintenance is the basis of the City's emergency response and recovery operations, and includes the following sections and supporting materials:

1. **Basic Plan** - Provides an overview of the City's emergency response organization and policies. It cites the legal authority for emergency operations, summarizes the situations addressed by the plan, explains the general concept of operations, and assigns general responsibilities for emergency planning and operations.
2. **Functional Annexes** - Each annex focuses on one of the critical emergency functions that are typically common for all hazards,

which the City will perform in response to an emergency. The type and scope of an incident will dictate which functional annexes will be needed.

3. **Hazard Specific Appendices** - The appendices provide additional detailed information and special considerations that are applicable to specific hazards. The appendices are to be used in conjunction with the Basic Plan and the Functional Annexes.[42]

### Tree Inventory Map - Scenic Tree Program

A map of hazardous trees in Beaverton provides information useful for targeting measures that mitigate against the effects of falling trees. Further to this goal, "The City of Beaverton Planning Department is currently working on long range tree preservation planning. This will help drive development away from hazard prone areas, and attempt to increase City's ability to mitigate for disasters."[43]

### Incident Command System

The Incident Command System (ICS) is a management system that may be used during any hazard event; it has three main components:

**Command** - A designated lead person responsible for:

- Assessing the situation and resources
- Developing and implementing an appropriate action plan
- Monitoring the effectiveness of the plan
- Reviewing/modifying the plan as changes occur

**Resource Control** - Resources must be properly directed to maximize their utilization.

**Communication** - In order to orchestrate and coordinate the use of resources at an incident, all members of the incident response team must be linked by:

- A well-defined organizational structure
- Clear lines of communication

### Transportation Plan

The City of Beaverton's adopted transportation plan is the Transportation Element of the City's Comprehensive Plan. It identifies the transportation improvements needed to accommodate existing and future development in the Beaverton area. The plan projects needs and improvements through 2015.

Beaverton's adopted transportation plan is based on an analysis contained in the Transportation System Plan (TSP), which was developed through a public participation process. The development of the TSP and thereafter the more concise Transportation Element, Chapter Six of the Comprehensive Plan, (a summary of the analysis, goals and policies, and improvements) are closely coordinated and intended to be consistent with other jurisdictions' transportation plans. These include Washington County's Transportation Plan, Metro's Regional Transportation Plan and Urban Growth Management Framework Plan, TriMet's short and long-range transit plans, and the State of Oregon Transportation Plan. Coordination with these and other jurisdictions and service agencies is continuous.

## County Programs

### Tualatin Valley Water District

To assist in protecting customers from the impacts of cold weather, the Tualatin Valley Water District (TVWD), which serves a small percentage of Beaverton, provides press releases to major media outlets to inform residents of predicted cold weather events, and to provide tips on how to avoid damage to plumbing systems.

Tualatin Valley Water District's (TVWD) exposure to windstorms is primarily limited to power loss. In the 1995 windstorm, TVWD's main operations station lost power for approximately twelve hours. During storms in 1996, TVWD lost power to pump stations. The main operations center and most pump stations have back-up generators to provide emergency power. However, if power is not available, pumps and gauges cannot function, and the system operators cannot accurately determine the amount of water available for use. Additionally, during the storms of 1996, TVWD paid visits to approximately ten-percent of its customers. Many of the visits were weather related. Rolling blackouts can pose serious problems to the water system. During summer, when water use is extremely high, emergency generators may provide power to meet peak demand.

### Portland General Electric

Through the Right Tree-Right Place program, Portland General Electric (PGE) educates homeowners, landscapers, and tree propagators on tree species that will not be subject to ongoing stress by constant trimming. PGE distributes brochures that list low-growing trees that fit within the utility right-of-way and are compatible with small urban planting strips. The brochure includes information on how to select the correct tree, the energy-saving benefits of trees, and proper planting and pruning techniques. PGE offers tree owners a certificate to help defray the cost of a new tree that replaces one that is inappropriate.

PGE also runs a tree-trimming program and keeps a database of information in order to build profiles of trees that cause power line outages. PGE foresters work with local government and the public to assess and identify situations in which trees or power lines put life and property at risk. Calls and faxes to PGE's tree-trimming program result in immediate response by PGE to clear roads of fallen trees. PGE's database of tree failures intends to identify those trees that are at an above average risk.

## Federal Programs

### National Weather Service

The Portland Office of the National Weather Service issues severe weather watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

# Severe Weather Mitigation Action Items (Not Including Flood)

The severe weather mitigation action items provide direction on specific activities that the City, organizations and residents can undertake to reduce risk and prevent loss from severe weather events. There are two short-term and five long-term severe weather action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

**ST-SW #1: Maintain public awareness of the hazard and the benefits of mitigation through education aimed at households and businesses and increase targeting of special needs populations.**

***Ideas for Implementation:***

- Collect additional information and add to existing informational sources.
- Update web-site information.
- Distribute audience specific educational materials to schools, churches, and other public and private sector organizations.
- Disperse educational materials through Beaverton Neighborhood Association Committees (NACs) and other neighborhood organizations.
- Develop methods of improving emergency warning system.
- Identify and contact at risk populations such as the elderly or disabled not living in group-homes/assisted care facilities.
- Create inventory of supplies available for at risk populations in severe winter storm situations.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development, Community Development
**External Partners:** Washington County, Utilities, Tualatin Valley Water District, American Red Cross, St. Vincent DePaul, Churches, Oregon Voluntary

Organizations Active in Disaster, Tualatin Valley Fire and Rescue

**Timeline:** 1-2 Years

**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community; Improve Partnerships for Communication and Coordination; Enhance Emergency Services

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**ST-SW#2: Maintain tree trimming for above ground power lines.**

***Ideas for Implementation:***

- Coordinate with overhead utilities to evaluate tree trimming activities.

**Coordinating Organization:** City of Beaverton

**Internal Partners:** Community Development, Emergency Management, Urban Forestry

**External Partners:** Washington County, Overhead Utilities

**Timeline:** Ongoing

**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

---

**LT-SW #1: Identify trees that are potentially susceptible to windthrow.**

***Ideas for Implementation:***

- Analyze current map of trees from the Scenic Tree Program, Tree Preservation Plan Map, Street Trees, and other sources.
- Develop education material on tree species that are susceptible to windthrow.
- Locate hazardous trees and add to map.

**Coordinating Organization:** City of Beaverton

**Internal Partners:** Operations, Urban Forestry, Information Systems Department – Geographic Information System

**External Partners:** Washington County, Overhead Utilities

**Timeline:** Ongoing

**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

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**LT-WS#2: Develop and implement programs to keep trees from threatening lives, property, and public infrastructure from severe weather events.**

***Ideas for Implementation:***

- Develop landscape and street tree standards that have fewer impacts on above ground utility lines and roads.

- Develop partnerships between utility providers, City and County agencies to document known hazard areas and minimize risks.
- Coordinate with overhead utilities in developing GIS layers for power lines and at risk trees.
- Collaborate with overhead utilities on “Right Tree – Right Place Program”

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Information Systems Department – Geographic Information System, Operations, Urban Forestry, Community Development
**External Partners:** Washington County, Overhead Utilities
**Timeline:** Ongoing
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

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**LT-SW #3: Develop and maintain comprehensive impact database and when possible, map historical severe weather events in Beaverton.**

***Ideas for Implementation:***

- Research and analyze historic windstorm damage in Beaverton.
- Identify reoccurring patterns
- Map reoccurring hazard sites.
- Document future events including impacts and losses.
- Develop partnerships between utility providers, City and County public works agencies to document known hazard areas and minimize risks.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Community Development, Information Systems Department – Geographic Information System.
**External Partners:** Washington County, National Weather Service, National Oceanic and Atmospheric Administration, Oregon Climate Service, Overhead Utilities
**Timeline:** Ongoing
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community; Improve Partnerships for Communication and Coordination

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**LT-SW #4: Support underground utility construction through public incentives and partnerships.**

*Ideas for Implementation:*

- Continue support of utility under grounding program in newly developed areas to minimize future conflicts with utilities.
- Increase the use of underground utilities where possible in redevelopment areas.
- Coordinate with local utility companies and contractors to install underground utilities.
- Partner with utilities to investigate under grounding utilities in older sections of Beaverton that are prone to hazards related to overhead utilities.
- Identify underground utilities projects as a part of future Capital Improvement Projects (CIPs).

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Community Development, Information Systems Department – Geographic Information System.
**External Partners:** Washington County, Overhead Utilities
**Timeline:** Ongoing
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

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**LT-SW #5: Develop strategies for better debris removal after a windstorm.**

*Ideas for Implementation:*

- Establish priorities for debris removal following severe weather events, including prioritizing arterials and collectors.
- Coordinate with those local agencies responsible for debris removal and provide residents locations for debris disposal.
- Notify area residents, business owners, and employees of alternative routes in case of road blockage.
- Develop a debris/fallen tree drop-off location for property owners after severe storm events.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Operations
**External Partners:** Washington County, Oregon Department of Transportation, Tualatin Hills Park and Recreation District, Clean Water Services, Metro, Cooperative Public Agencies of Washington County, Regional Recycling Facilities, Waste Management
**Timeline:** Ongoing
**Plan Goals Addressed:** Create a Disaster Resistant and Resilient Community

# Severe Weather Resource Directory

## City Resources

### Emergency Management Program

The City has established an Emergency Management Program consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). It is organized under the auspices of the City Council and works under the overall supervision of the Mayor.

The City has an Emergency Manager who is part of the Mayor's Office and who is responsible for managing the City's program in all four phases of Emergency Management. Responsibilities of the City's Emergency Manager include:

- Development and maintenance of the City's Response, Recovery, Preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies

**Contact:** Emergency Manager, City of Beaverton Emergency Management
**Address:** 20665 SW Blanton St. Aloha, OR, 97007
**Phone:** (503) 642-0383
**Website:** www.ci.beaverton.or.us/departments/emergency/
**Email:** emergmngmail@ci.beaverton.or.us

### Community Development Department

The Community Development Department consists of the Administration, Building, Development Services, GIS and Planning Services Divisions. The functions of the department include Community Planning, administration of the Community Development Code as it relates to Land Development, Building Plan Review and Inspections, and Customer Service.[44]

**Contact:** Director, Community Development Department
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2493
**Website:** http://www.ci.beaverton.or.us/departments/cdd
**Email:** cddmail@ci.beaverton.or.us

### Engineering Department

The Engineering Department's mission is to provide excellent engineering and construction support services to the citizens and administration of the City of Beaverton in the areas of capital improvements and modifications to the City infrastructure, traffic and transportation and water system operation and maintenance.

**Contact:** Director, Department of Engineering
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2269
**Website:** www.ci.beaverton.or.us/departments/engineering/
**Email:** engmail@ci.beaverton.or.us

### Operations and Maintenance Department

The Operations and Maintenance Department is responsible for providing a wide variety of maintenance activities to ensure the long-term integrity of the City's infrastructure. Maintenance activities include: City Landscapes & Trees; Roadways; Pedestrian/Bike Paths; Traffic Signals; Streetlights; Underground Storm Drainage Pipes; Water Quality Facilities; Underground Sanitary Sewer Pipes; City Facilities; City Vehicles & Equipment.

Contact**: Operations Director**
Address**: 9600 SW Allen Boulevard, Beaverton, OR 97005**
Phone**: (503) 526-2220**
Website**: www.ci.beaverton.or.us/departments/operations/**
Email**: opsmail@ci.beaverton.or.us**

### Finance Department

The Information Systems Department is part of the Finance Department and includes GIS Services.

Contact**: Finance Director**
Address**: 4755 SW Griffith Dr., Beaverton, OR 97005**
Phone**: (503) 526-2435**
Website**: www.ci.beaverton.or.us/departments/finance/**
Email**: financemail@ci.beaverton.or.us**

## County Resources

### Office of Consolidated Emergency Management

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the County's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the County sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff.

Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the Cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated

Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact**: Director, Washington County Emergency Management
**Address**: 20665 SW Blanton St. Aloha, OR, 97007
**Phone**: (503) 642.0371
**Website**: http://www.ocem.org
**Email**: info@ocem.org

### Land Use and Transportation Department

The Washington County Land Use and Transportation Department plans, builds and maintains the County's transportation systems and prepares, implements, and enforces land use plans and policies.

**Contact**: Washington County Land Use and Transportation
**Address**: Land Use and Transportation Department, 155 N. First Avenue, Suite 350, Hillsboro, OR 97124
**Phone:** (503) 846-3470
**Website:** http://www.co.washington.or.us/deptmts/lut/lut.htm
**Email**: lutdir@co.washington.or.us

### Clean Water Services (CWS)

Clean Water Services (formerly the Unified Sewerage Agency) provides sanitary sewer and storm water management services to large portions of Washington County. CWS works with the County and the Cities within the County to build and maintain public drainage systems that meet public need and comply with regulations set by the Oregon Department of Environment Quality. CWS maintains storm sewers and pipelines, open drainage ditches, and stormwater detention ponds. CWS also develops long-term flood management plans, including, but not limited to, protection of riparian buffer areas and wetland preservation.

**Contact**: Clean Water Services
**Address**: 155 N. First Ave. Suite 270, Hillsboro, OR 97124
**Phone**: (503) 846-8621
**Fax**: (503) 846-3525
**Website**: http://www.cleanwaterservices.org

## State Resources

### Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 statewide planning goals, including Goal 7, related to natural hazards, with flood as its major focus. In order to help local governments address natural hazards effectively, DLCD provides technical assistance such as conducting workshops, reviewing local land use plan amendments, and working interactively with other agencies.

**Contact:** Natural Hazards Program Manager, DLCD
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033

**Website**: http://www.lcd.state.or.us/hazards.html

### Oregon Department of Consumer and Business Services

The Building Codes Division of Oregon's Department of Consumer and Business Services is responsible for administering statewide building codes. Its responsibilities include adoption of statewide construction standards that help create disaster-resistant buildings, particularly for flood, wildfire, wind, foundation stability, and seismic hazards.

**Contact:** Building Codes Division
**Address:** 1535 Edgewater St. NW, P.O. Box 14470, Salem, OR 97309
**Phone:** (503) 373-4133
**Fax:** (503) 378-2322
**Website:** http://www.cbs.state.or.us/external/bcd

### Oregon Climate Service

The Oregon Climate Service collects, manages, and maintains Oregon weather and climate data. OCS provides weather and climate information to those within and outside the state of Oregon and educates the citizens of Oregon on current and emerging climate issues. OCS also performs independent research related to weather and climate issues.

**Contact**: Oregon Climate Service
**Address**: Oregon Climate Service, Oregon State University
Strand Ag Hall Room 316, Corvallis, OR 97331-2209
**Phone**: (541) 737-5705
**Website**: http://www.ocs.orst.edu
**Email**: oregon@oce.orst.edu

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing, and providing for the prevention, mitigation, and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the state of Oregon.

**Contact**: Office of Emergency Management
**Address**: 595 Cottage Street NE, Salem, OR 97310
**Phone**: (503) 378-2911
**Fax**: (503) 588-1378
**Website**: http://www.osp.state.or.us/oem

## Federal Resources

### Federal Emergency Management Agency (FEMA)

FEMA's mission is "to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

**Contact**: FEMA, Federal Regional Center, Region 10
**Address**: 130-228th St. SW, Bothell, WA 98021-9796
**Phone**: (425) 487-4678
**Website**: http://www.fema.gov/Reg-X/index.htm

### National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

**Contact**: National Oceanic and Atmospheric Administration
**Address**: 14th Street & Constitution Avenue, NW, Room 6013, Washington, DC 20230
**Phone**: (202) 482-6090
**Fax**: (202) 482-3154
**Website**: http://www.noaa.gov
**Email:** answers@noaa.gov

### National Weather Service, Portland Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

**Contact**: National Weather Service
**Address**: 5241 NE 122nd Ave, Portland, Oregon 97230
**Phone**: (503) 326-2340
**Website**: http://nimbo.wrh.noaa.gov/Portland
**Email**: clinton.rockey@noaa.gov

## Additional Resources

### American Red Cross

The American Red Cross is a humanitarian organization, led by volunteers, that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area, including disaster planning, preparedness, and education.

**Contact**: American Red Cross, Oregon Trail Chapter
**Address**: P.O. Box 3200, Portland, OR 97208-3200
**Phone**: (503) 284-1234
**Fax**: (503) 284-4247

**Website**: http://www.redcross-pdx.org
http://www.redcross.org/services/disaster
**Email**: info@redcross-pdx.org

### Institute for Business & Home Safety (IBHS)

IBHS was created as an initiative of the insurance industry to reduce damage and losses caused by natural disasters. Their website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

**Contact**: Institute for Business and Home Safety
**Address**: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
**Phone**: (813) 286-3400
**Fax**: (813) 286-9960
**E-mail**: info@ibhs.org
**Website**: http://www.ibhs.org/ibhs2

## Publications

### *Public Assistance Debris Management Guide*, Federal Emergency Management Agency (July 2000).

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

**Contact**: FEMA Distribution Center
**Address**: 130 228th Street, SW, Bothell, WA 98021-9796
**Phone**: (800) 480-2520
**Fax**: (425) 487-4622
**Website**: http://www.fema.gov/rrr/pa/dmgtoc.shtm

## Endnotes

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[2] *Valley Times*, "Worst Storm Since '62 Hits Area Monday Night," 1967.

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[12] Ibid.

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[22] Ibid.

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[24] National Weather Service Web-Page, http://www.wrh.noaa.gov/Portland/windstorm.html. (Accessed February 20, 2003).

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[36] J., Young, City of Beaverton Economic Development, personal communication, April 11, 2003

[37] Portland General Electric, http://www.portlandgeneral.com, (April 2001).

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[41] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/emergency/emergency_eoc.html, (Accessed 4/30/03) (Entire Paragraph)

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# Chapter 9
# Landslide

# Table of Contents

# Why are Landslides a threat to Beaverton?

Landslides are a serious geologic hazard that exists in almost every state in the United States. Nationally, landslides cause 25 to 50 deaths each year.[1] The best estimates of the direct and indirect costs of landslide damage in the United States range between $1 billion to $2 billion annually.[2] In Oregon, a significant number of locations are at risk to dangerous landslides. While landslides have had little to no impact in Beaverton, they have created a number of problems throughout Washington County. Although not all landslides result in private property damage, many landslides impact transportation corridors, fuel and energy conduits, and communication facilities. [3] They can also pose a serious threat to human life.

Landslides can be broken down into two categories: (1) rapidly moving; and (2) slow moving. Rapidly moving landslides (debris flows and earth flows) present the greatest risk to human life, and persons living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide-related injuries and deaths in Oregon. A rapidly moving debris flow in Douglas County killed five people during the storms of 1996. Slow moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

## Landslide Characteristics

### What is a Landslide?

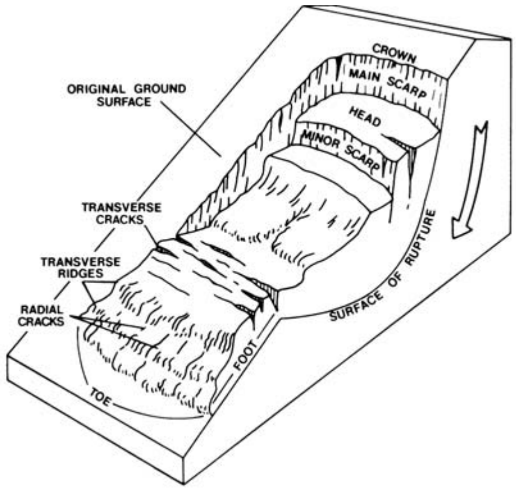
Landslides are downhill or lateral movements of rock, debris, or soil mass. The size of a landslide usually depends on the geology and the triggering mechanism. Landslides initiated by rainfall tend to be smaller, while those initiated by earthquakes may be very large.

Slides associated with volcanic eruptions are typically large and can include as much as one cubic mile of material. Slides caused by erosion occur when ditches or culverts beneath hillside roads become blocked with debris. If the ditches are blocked, run-off from slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil, and in some cases, cause a slide. Usually the slides are small (100 – 1,000 cubic yards), but some have been known to be quite large.

Landslides can vary greatly in the volumes of rock and soil involved, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some of the characteristics that determine the type of landslide are the slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names depending on the type of failure and their composition and characteristics. Types of landslides include slides, rock falls, and flows.

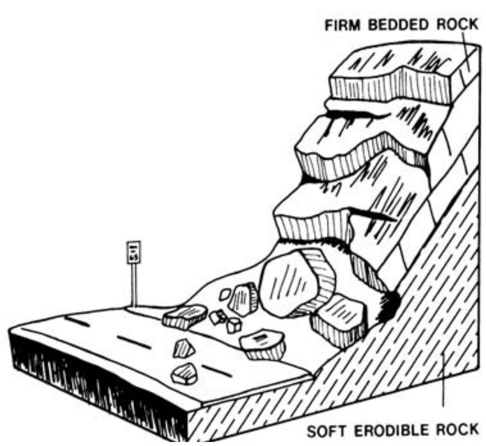
**Slides** move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface, and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow (See Figure 9.1). Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.[4]

**Figure 9.1. Rotational Slide**




**Rock falls** (see Figure 9.2) occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, where the road has been cut through bedrock can cause falls. These slides are fast moving with the materials free falling or bouncing down the slope. The total volume of material involved is generally small, but individually the boulders or blocks of rock can be large and can cause significant damage.

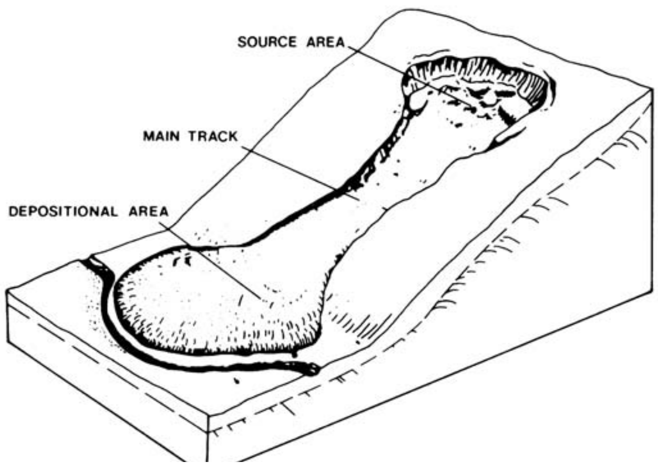
**Figure 9.2. Rock Fall**




Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCD

**Flows** (see Figure 9.3) are slides in which soil and rock breaks up and flows like a plastic or liquid. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically fast moving and also tend to increase in volume as they scour out the channel.[5] Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances. One example of a flow in Oregon is the Dodson debris flow that occurred in 1996. This debris flow started high on the Columbia Gorge cliffs, and traveled far down steep canyons to form debris fans at Dodson.[6] Earthquakes often trigger flows. [7]

**Figure 9.3. Earthflow**




Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCD

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt but earthquakes, volcanic activity, and excavations might also trigger them. Certain geologic formations are more susceptible to landslides than others. Human activities, including development on or near steep slopes, can increase susceptibility to landslide events. Because of their general nature, landslides on steep slopes are typically more dangerous because they can occur with little warning and their movements can be very rapid.

**What locations are at risk from landslides and debris flows?**

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills;
- Steep road-cuts or excavations into steep slopes;
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
- Steep areas where surface runoff is channeled, such as below ground in culverts, V-shaped valleys, canyon bottoms, and steep stream channels;
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons, large boulders (2 to 20 feet diameter) perched on soil near fans or adjacent to creeks; and
- Occurrences of logjams in streams.[1]

## Landslide Conditions

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.[8]

### Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. Steep, concave-shaped slopes with larger drainage areas appear to be more susceptible to landslides than other landforms. Rainfall-initiated landslides tend to be smaller but occur frequently, while earthquake-induced landslides may be very large, but are less frequent. Landslides are particularly common along stream banks, reservoir shorelines, large lakes, and the seacoasts. The removal of material supporting the shoreline by currents and waves or undercutting during construction at the base of a slope produces countless small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks. Landslides associated with volcanic eruptions can include volumes of over one cubic mile of material. All soil types can be affected by natural landslide triggering conditions.

### Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading of these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. Additionally, the added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides that occur below new construction sites are often indicators of the impacts stemming from excavation.

### Drainage and Groundwater Alterations

Water flowing through or over the ground is often a trigger for landslides. Drainage can be affected naturally by the geology and topography of an area or by man-made activities. Any activity that increases the amount of water flowing onto slopes can increase the potential of landslides. Channels, streams, ponding, and erosion on slopes are all indicators of potential slope problems.

Ineffective storm water management, including water retention facilities that direct water onto slopes, and excess runoff can cause erosion and generate landslides. Development that results in an increase in the amount of impervious surfaces impairs the ability of the land to absorb water and may redirect the run-off into other areas. As a result, more landslides could occur. Broken or leaking water or sewer lines can also be problematic as well as lawn irrigation and minor alterations to small streams in landslide prone locations. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.[9]

### Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. The *Storm Impacts Study* conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of 10 years after timber harvesting.[10] Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may increase the severity the impacts from debris flows.[11]

### Development

Development sites with the greatest risk from landslides are those located against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. While home development sites at the base of slopes do not cause landslides, they do put residents and property at risk of landslide impacts. The simplest mitigation measure for this situation is to locate the home out of the impact area, or construct debris flow diversions for homes at risk. Three development-related actions that can put people at risk include:[12]

1. **Creating Steeper Slopes**. Excavation practices, sometimes aggravated by drainage, can reduce the stability of otherwise stable slopes. These failures commonly affect only a small number of homes. Without these excavation practices, there is little risk of landslides in areas not prone to landslide movement.
2. **Development on or Adjacent to Existing Landslides**. Existing landslides are generally at risk of future movement regardless of excavation practices. Excavation and drainage practices can further increase risk of landslides. In many cases, there are no development practices that can completely assure stability. Homeowners and communities in these situations accept some risk of future landslide movement.
3. **Development on Gentle Slopes**. Development on gentle slopes can be subject to landslides that begin a long distance from the development.

Informing new residents, long-time homeowners, and developers about the risks associated with landslides is an important issue related to landslide location and occurrence.

For more information on soils, contact the Natural Resource Conservation Service:
NRCS, Oregon Branch
101 S.W. Main Street, Suite 1300, Portland, OR 97204
Phone: (503) 414-3200
Fax: (503) 414-3103

Developers who are uninformed about geological materials and processes may contribute to conditions that trigger landslide activity or increase susceptibility to landslide hazards.[13]

Beaverton's grading permits development standards require appropriate safeguards when the following soil conditions occur:

- Seasonal, perched, high, or apparent water table;
- High shrink-swell capability;
- Low bearing strength such as compressible organics; and
- Shallow depth to bedrock.[14]

## Community Landslide Issues

Landslides can affect utility services, transportation systems, and critical lifelines. In addition to the immediate damages and loss of service that communities may suffer, the disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electricity are all essential to the community. Loss of electricity has the most widespread impact on the whole community, and can even affect other utilities. For example, even landslide movements as small as an inch or two increase the potential for natural gas pipelines to break.[15]

Source: American Planning Association Landslides

### Roads

Roads are subject to closure during landslide events. Since many Beaverton residents are dependent on roads for commuting to work, delays and detours generated by a landslide event will likely have an economic impact on residents and businesses. To evaluate the benefit of landslide mitigation activities for roads, the city should take into consideration the number of vehicle trips per day over the identified section of road, the increase in travel time the detour around a road closure will cause, and whether the road is used for commercial traffic or emergency access.[16]

# Landslide Hazard Assessment

## Hazard Identification

Hazard identification is the first phase of a hazard assessment, and is the process of estimating the geographic extent of the hazard, its intensity, and its probability of occurrence.[17] This process usually results in a hazard map. Hazard maps can provide detailed information in a clear format and can assist in making policy and land use decisions. Landslides in surrounding areas of Beaverton have primarily been slow moving and caused greatest impact to roads and culverts.[18]

Only been one known landslide has occurred within current city boundaries. The slide occurred on a man-made slope which is part of the Highway 217 overpass over the Beaverton-Hillsdale Highway. There was no direct impact on the roadways, utilities, or structures.

While recent landslide events near Beaverton have not been the rapidly moving debris flows, the potential for their occurrence exists. Debris flows generally occur during intense periods of rainfall on previously saturated soil. They typically start on steep slopes and can accelerate to speeds as great as 35 mph. Debris flows have caused most of the recent landslide related injuries and deaths in Oregon,[19] and they have been the catalyst for the creation of two state agencies: (1) the Oregon Department of Forestry (ODF); and (2) the Department of Geology and Mineral Industries (DOGAMI) to map these types of landslides.

ODF has mapped debris flows in some areas of Washington County, including locations subject to naturally occurring debris flows, initiation sites and projected paths. More information on ODF's debris flow maps can be found by contacting ODF directly. Contact information for ODF is included in the resource directory section of this mitigation plan on page 9-24. In this plan's Map Section the map titled Natural Hazards notes debris flow and steep slopes in Beaverton.

Metro and Portland State University have also generated a map documenting Landslide Locations (1996-1997) and Zones of High Landslide Potential in the Portland Metropolitan Region.

## Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through landslide identification with an inventory of the existing development exposed to landslide hazards. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.[20] The optimum method for doing this analysis at the county or jurisdiction level is to use parcel-specific assessment data on land use and structures.[21] Data that includes known landslide and debris flow locations can be used to assess the population and total value of property at risk from future landslide occurrences.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not been conducted for the Beaverton landslide event, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerabilities existing in other areas of the city and areas identified for future annexations. Landslides can impact major transportation arteries, blocking residents from essential services and businesses. While past landslide events have not caused major property damage or significantly impacted City residents, continuing to map City landslide and debris flow areas will help in preventing future loss.

## Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon hazard identification and vulnerability assessments.

Factors included in assessing landslide risk include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. This type of analysis could generate estimates of the damages to the City due to a landslide or debris flow event in a specific location. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

***Long-Term Landslide Action Item #1:***
Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in those areas.

*See page 9-18 for more information.*

The Oregon Department of Forestry and the Department of Geology and Mineral Industries are active in developing maps and collecting data on hazard risk. Developing partnerships with these agencies and other state and federal organizations can facilitate future strides in doing risk analysis for landslide hazards.

# Mitigation Plan Goals and Existing Activities

## Mitigation Plan Goals and Public Priorities

The mitigation plan goals and action items are derived from review of regional and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Plan Steering Committee, and interviews with City of Beaverton stakeholders. The goals for the Beaverton Natural Hazards Mitigation Plan are broad based to include all of the identified hazards addressed in the plan. Goals for the mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Hazard Communication and Coordination through Partnerships
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

## Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations.

## City Programs

### City of Beaverton Codes

Goals, actions, and or regulations related to development on slopes, can be found in Beaverton's Comprehensive Plan, Development Code, City Code, and Engineering Design Manual.

### Capital Improvement Plan

The City of Beaverton's Capital Improvements Plan (CIP) is a dynamic document that lists and prioritizes needed improvements and expansions of the City's infrastructure system to maintain adequate service levels to existing City residents and businesses, and to accommodate population growth and land development. The CIP reflects the needs and priorities established by the City and the resources available to the City. The CIP can be modified during the fiscal year, through the supplemental budget process, as needs, priorities, and resources change. The CIP can assist the City of Beaverton in mitigating against severe weather events by improving infrastructure most prone to damage.

### Emergency Operation Center (EOC)

The Emergency Operations Center is an established location/facility in which City staff and officials can receive information pertaining to an incident and from which they can provide direction, coordination, and support to emergency operations. City personnel who are assigned to specific positions within the EOC organizational structure staff the EOC. The structure is based on the National Interagency Incident Command System (ICS). The EOC staff provides information and recommendations to the Mayor, through the Incident Commander or as directed, to develop a course of action to respond to and contain, control, and recover from an emergency. Some of the primary functions that are performed at the EOC include: coordination, operations management, planning, information tracking and dissemination, logistical support, financial management and support, and emergency public information.[22]

### Emergency Response and Recovery Plan (ERRP)

The Emergency Response and Recovery Plan (ERRP) describes the roles and responsibilities of the departments and personnel for the City of Beaverton during major emergencies or disasters.

The Plan sets forth a strategy and operating guidelines using the National Interagency Incident Management System's ICS adopted by the City for managing its response and recovery activities during disasters and emergencies.

The ERRP's development and maintenance is the basis of the City's emergency response and recovery operations. It includes the following sections and supporting materials:

1. **Basic Plan** - Provides an overview of the City's emergency response organization and policies. It cites the legal authority for emergency operations, summarizes the situations addressed by the plan, explains the general concept of operations, and assigns general responsibilities for emergency planning and operations.
2. **Functional Annexes** - Each annex focuses on one of the critical emergency functions that are typically common for all hazards, which the City will perform in response to an emergency. The type and scope of an incident will dictate which functional annexes will be needed.
3. **Hazard Specific Appendices** - The appendices provide additional detailed information and special considerations that are applicable to specific hazards. The appendices are to be used in conjunction with the Basic Plan and the Functional Annexes.[23]

### Incident Command System

The Incident Command System (ICS) is a management system that may be used for any time of hazard event, and has three main components:

**Command** - A designated lead person responsible for:

- Assessing the situation and resources
- Developing and implementing an appropriate action plan

- Monitoring the effectiveness of the plan
- Reviewing/modifying the plan as changes occur

**Resource Control** - Resources must be properly directed to maximize their utilization.

**Communication** - In order to orchestrate and coordinate the use of resources at an incident, all members of the incident response team must be linked by:

- A well-defined organizational structure
- Clear lines of communication

## Transportation Plan

The City of Beaverton's adopted transportation plan is the Transportation Element of the City's Comprehensive Plan. It identifies the transportation improvements needed to accommodate existing and future development in the Beaverton area. The plan projects needs and improvements through 2015.

Beaverton's adopted transportation plan is based on an analysis contained in the Transportation System Plan (TSP), which was developed through a public participation. The development of the TSP and thereafter the more concise Transportation Element, Chapter Six of the Comprehensive Plan, (a summary of the analysis, goals and policies, and improvements) are closely coordinated and intended to be consistent with other jurisdictions' transportation plans. These include Washington County's Transportation Plan, Metro's Regional Transportation Plan and Urban Growth Management Framework Plan, TriMet's short and long-range transit plans, and the State of Oregon Transportation Plan. Coordination with these and other jurisdictions and service agencies is continuous.

## County Programs

### Washington County Community Development Code

*Article IV: Development Standards, 410 Grading and Drainage, 1.2, D (2) states:*

> For areas outside the Tualatin River and Oswego Lake sub-basins, an erosion control plan that complies with the requirements of the "Washington County Erosion Control Plans Technical Guidance Book," January 1991, or its successor, is required when, (a) grading requiring a permit is conducted or left in an unfinished state during October 1 through May 1; or (b) land disturbance activities are conducted in geologically unstable areas, on slopes in excess of twenty (20) percent, or there is disturbance of more than six-thousand (6,000) square feet of any drainage hazard area or flood plain area.

**410 Grading and Drainage, 3 (permit approval) states:**

Permit approval for construction, grading, cut, or fill is dependent on the following conditions:

- The extent and nature of the proposed grading is appropriate to the use proposed and will not create site disturbance to an extent greater than that required for the use;
- Proposed grading will not cause erosion to any greater extent than would occur in the absence of development or result in erosion, stream sedimentation, or other adverse off-site effects of hazards to life or property; and
- Appropriate siting and design safeguards shall ensure structural stability and drainage in areas with soil conditions of seasonal, perched, high or apparent water table, high shrink-swell capability, low bearing strength such as compressible organics, or shallow depth to bedrock.

**Article IV: Development Standards, 426, Erosion Control, 4 states:**

Every preliminary plat, site plan, development permit, building permit, or public works project within the Tualatin River and Oswego Lake sub-basins must prepare an erosion control plan. This plan includes a list of best management practices to be applied during construction to control and limit soil erosion. Permitting is dependent upon the development of an erosion control plan. The plan must be prepared in conformance with the Washington County Erosion Control Plans Technical Guidance Book, January 1991, or its successor.

**Article IV: Development Standards, 405, Open Space, 1 states:**

Areas defined as confirmed land movement hazard areas, as identified through the application of the standards of Section 410 or mapped as a Significant Natural Area on the Community Plan, shall be preserved as open space.

## State Programs

### Oregon State Senate Bill 12

The 1997 Legislature passed Senate Bill 12 to address problems caused by landslides and debris flows. Provisions include:

- Allowing the Oregon State Forester to prevent timber harvest or road construction in or below areas identified by the Department of Forestry as “high risk sites” and where homes or highways are in precarious locations.
- Allowing road officials to close roads that pose risk to human life because of landslides.

- Requiring State agencies to develop, and local officials to distribute, information about hazards of construction on sites that are vulnerable to landslides.
- Establishing a 10-member Task Force on Landslides and Public Safety to assess the problem and develop a solution. It includes legislators and representatives from state natural resource agencies, boards of commissions, local government, and the public.

### Debris Flow Mapping

Currently, two state agencies are involved in mapping debris flows: (1) the Oregon Department of Forestry and (2) the Department of Geology and Mineral Industries (DOGAMI). Senate Bill 12 requires that the Department of Geology and Mineral Industries, with cooperation from local governments and the Department of Forestry, identify and map landslide-prone areas, or "further review areas." Senate Bill 12 defines a further review area as "an area of land in which further site specific review should occur before land management or building activities begin."[24]

### Oregon Department of Forestry (ODF)

The Oregon Department of Forestry has provided a preliminary indication of debris flow (rapidly moving landslides) in western Oregon. Their debris flow maps include the general locations subject to naturally occurring debris flows and include the initiation sites and locations along the paths of potential debris flows (confined stream channels and locations below steep slopes). These maps do not consider the effects of management-related slope alterations (drainage and excavation) that can increase the hazard, nor do they consider very large landslides that could possibly be triggered by volcanic or earthquake activity. Areas identified in these maps are not to be considered "further review areas" as defined by Senate Bill 12 (1999).[25]

Information used to develop the ODF Debris Flow maps include:

- Digital elevation models at 30-meter resolution, based on US Geological Survey data, were used to derive slope steepness and then to develop polygons for assigned hazards. Note that actual slopes are steeper than these digitally elevated models.
- Mapped locations of Tyee soil formation and similar sedimentary geologic units.
- Oregon Department of Forestry *Storm Impacts and Landslides of 1996* study; debris flow initiation and path location data.
- Stream channel confinement near steep hill slopes based on US Geological Survey Digital Raster Graphics.
- Historical information on debris flow occurrence in western Oregon (from Oregon Department of Forestry, US Forest

Service, DOGAMI, Bureau of Land Management, and the Oregon Department of Transportation).

- Fan-shaped land formations below long, steep slopes.
- Areas of highest intensity precipitation do not appear to be correlated with known areas of high and extreme debris flow hazard, so precipitation intensity was *not* used to develop risk (hazard) ratings.[26]

### Prohibition of Certain Forest Operations

As part of the requirements of Senate Bill 12, ODF is currently administering the deferral of certain forest operations on landslide-prone sites above homes and roads. The Department's policy is that timber harvesting or road construction operations will be prohibited on land where landslides or debris flows pose a significant threat to human safety. Exceptions for salvage or other purposes are considered on an individual basis, but have been infrequent in keeping with the intent of preventing significant risks to human life.[27]

### Debris Flow Warning System

The debris flow warning system was initiated in 1997 and involves collaboration between ODF, DOGAMI, the Oregon Department of Transportation (ODOT), local law enforcement, NOAA Weather Radio, and local media.

ODF meteorologists are responsible for forecasting storms that may trigger debris flows. Information is broadcast over NOAA Weather Radio, and on the Law Enforcement Data System. DOGAMI provides additional information on debris flows through the media. ODOT provides warning signs to motorists in landslide-prone areas during high-risk periods.[28]

### Landslide Brochure

DOGAMI developed a landslide public outreach brochure in cooperation with several other state agencies. Forty thousand copies were printed in November1997 and were distributed widely to building codes officials, county planners, local emergency managers, field offices of natural resource agencies, banks, real estate companies, insurance companies, and other outlets. Landslide brochures are available from DOGAMI, OEM, ODF, and the Department of Land Conservation and Development (DLCD).[29]

### Oregon State Building Code Standards

The Oregon Building Codes Division adopts statewide standards for building construction that are administered by state and local municipalities throughout Oregon. The One- and Two-Family Dwelling Code and the Structural Specialty Code contain provisions for lot grading and site preparation for the construction of building foundations.

Both codes contain requirements for cut, fill, and sloping of the lot in relationship to the location of the foundation. There are also building setback requirements from the top and bottom of slopes. The codes specify foundation design requirements to accommodate the type of soils, the soil bearing pressure, and the compaction and lateral loads from soil and ground water on sloped lots. The building official has the authority to require a soils analysis for any project where it appears the site conditions do not meet the requirements of the code, or that special design considerations must be taken. ORS 455.447 and the Structural Code require a seismic site hazard report for projects that include essential facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures, such as large schools and prisons.[30]

Impacts from 1996 Landslide Event, Dairy Creek Rd.
Source: Community Planning Workshop

## Case Study: Salem Landslide Ordinance

The 1996 flood events contributed to two major landslide events, which forced the city into litigation. Through FEMA's Hazard Mitigation Grant Program, the city of Salem, Marion County, and DOGAMI received $250,000 to map landslide areas and develop a landslide ordinance.

The ordinance requires the preparation and approval of geological assessments before development occurs in areas identified with a moderate degree of hazard. Those areas then undergo a preliminary review of geologic conditions. The ordinance requires staff to determine if a geotechnical report requiring more information and detail than the geological assessment is necessary. This approach ensures adequate review of proposed development on private property where potentially greater risk requires more detailed information to fully identify and address the hazard. Additionally, prior to development, a declaratory statement indicating that the property is within an identified hazard area must be recorded on the property deed. Compliance with the ordinance is required as part of any land use permit and building permit for regulated activities within identified hazard areas.[31]

The Salem ordinance identified four key elements:

1) **Identify the hazard**. DOGAMI produced water-induced and earthquake-induced landslide maps for South Salem and Eola Hills. The ordinance incorporates slope steepness and hazard areas. The slope steepness criteria were done to address hillside development, which was not included in the mapping process. Additionally, Salem's Building and Safety Division has a kiosk where people can print out relative landslide maps of site-specific areas.

2) **Determine when to regulate**. The city developed a graduated response table that is used to determine the level of site investigation for various types of regulated activities on property within the mapped area. Landslides with moderate or high susceptibility may be subject to regulation (this is determined by the regulated activity).

3) **Establish an assessment process for hazard areas.** This is a procedural ordinance that documents when to require a geological assessment prepared by a Certified Engineering Geologist or a geotechnical report prepared by both a Certified Engineering Geologist and a registered Geotechnical Engineer. When development is in a high-risk area, both the geological assessment and the geotechnical report are required. Defining the roles was an important part of this process.

4) **Share the responsibility of hillside development.** Partnerships with state and local officials, residents, and businesses can reduce risk and prevent loss by bringing all their concerns to the table.

### Why is the Salem landslide ordinance useful?

The percentage of vacant land in landslide areas underscores the necessity of developing landslide hazard mitigation activities. The potential for future development necessitates strong regulation to reduce risk from potential landslide events.

The ordinance requires that an appropriate level of *study* occur before development occurs. While the process of developing a new ordinance was not without controversy, it was a collaborative project. Collaborative partnerships assist in future implementation. DOGAMI, OEM, DLCD, Marion County, the Board of Examiners, State Engineering Board, and city of Salem played a role in developing the ordinance.

**For more information, contact:**
City of Salem
555 Liberty St. SE/Room 305, Salem, OR 97301-3503
Phone: (503) 588-6211
Fax: (503) 588-6005
http://www.open.org/~naturalr/Landslides/landslide_Ord.htm

## Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that cities, organizations, and residents in Beaverton can undertake to reduce risk and prevent loss from landslide events. There are five long-term landslide hazard action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

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**LT-LS#1: Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in those areas.**

Ideas for Implementation

- Continue mapping county landslide and debris flow areas.
- Identify the location and extent of hazard areas and establish a factual base to support implementation of future measures; and
- Analyze the risk of these areas to life, property, and infrastructure.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners**: | Community Development Department |
| **External Partners**: | Department of Geology and Mineral Industries (DOGAMI), Oregon Department of Forestry (ODF), Clean Water Services. Washington County |
| **Timeline**: | Ongoing |
| **Plan Goals Addressed**: | Improve Partnerships for Communication and Coordination; Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards |

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**LT-LS#2: Limit activities in identified landslide hazard areas through regulation and public outreach.**

Ideas for Implementation

- Use the hazard identification and mapping processes to determine where to regulate. For example, develop a system, such as Salem's graduated response table, to determine where regulation should occur;
- Coordinate with property owners to reduce risk in landslide hazard areas;
- Provide information on hazard location to future residents; and
- Show hazard susceptibility on deeds.

| | |
|---|---|
| **Coordinating Organization**: | City of Beaverton |
| **Internal Partners**: | Community Development Department |

**External Partners**: Oregon Department of Forestry (ODF), Washington County, Committee for Citizen Involvement (CCI)
**Timeline**: Ongoing
**Plan Goals Addressed**: Improve Partnerships for Communication and Coordination; Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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### LT-LS#3: Protect existing development in landslide-prone areas.[32]

#### Ideas for Implementation

- Provide information to residents on landslide prevention. Publications such as FEMA's Homeowner's Landslide Guide for Hillside Flooding, Debris Flows, Erosion, and Landslide Control and Hillside Drainage Flyer have some ideas about reducing landslide susceptibility;
- Encourage easements to restrict certain activities on landslide-prone properties. Easements foregoing the right to develop a property can be either sold or granted to the City or other organizations by property owners;
- Investigate land purchasing programs;
- Use Transfer of Development Rights to transfer development rights of a landslide hazard area by deed, easement, or other legal instrument authorized by local law to another parcel of land that is not prone to landslides;
- Construct debris flow diversions to protect existing properties; and
- Use and publicize the Oregon Department of Forestry's debris flow warning system.

**Coordinating Organization**: City of Beaverton
**Internal Partners**: Community Development Department
**External Partners**: Department of Land Conservation and Development (DLCD), Oregon Emergency Management (OEM), Federal Emergency Management Agency (FEMA), Washington County
**Timeline**: Ongoing
**Plan Goals Addressed**: Improve Partnerships for Communication and Coordination; Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Ensure Implementation of Mitigation Activities

**LT-LS#4: Implement construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.**

Ideas for Implementation

- Where appropriate, reduce the number of building sites and corresponding disruption of the natural contour and vegetation;
- Remove access from alleys on the uphill side of a street;
- Reduce driveway cuts into the hillside;
- Adjust the building setback from property lines to minimize building site cuts and fills;
- Regulate the amount of vegetation cleared off hillside lots;
- Require erosion control techniques, such as the temporary use of hay bales, diversion dams, or other physical changes to control storm runoff during road and site construction; and
- Reduce water input into slopes from building roof drains, storm drains, and surface runoff.

**Coordinating Organization**: City of Beaverton
**Internal Partners**: Community Development Department, Engineering Department
**External Partners:** Department of Land Conservation and Development (DLCD), Clean Water Services, Washington County
**Timeline**: 1-3 years
**Plan Goals Addressed**: Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Ensure Implementation of Mitigation Activities

**LT-LS#5: Maintain public and private drainage systems.**

Ideas for Implementation

- Ensure that ditches, storm water facilities, and culverts are inspected and cleared prior to the wet season each year.

**Coordinating Organization**: Beaverton
**Internal Partners**: Operations/Maintenance Department
**External Partners:** Clean Water Services, Washington County
**Timeline:** Ongoing
**Plan Goals Addressed:** Improve Partnerships for Communication and Coordination; Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Ensure Implementation of Mitigation Activities

# Landslide Resource Directory

## City Resources

### Emergency Management Program

The City has established an Emergency Management Program consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). It is organized under the auspices of the City Council and works under the overall supervision of the Mayor.

The City has an Emergency Manager who is part of the Mayor's Office and who is responsible for managing the City's program in all four phases of Emergency Management. Responsibilities of the City's Emergency Manager include:

- Development and maintenance of the City's Response, Recovery, Preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees
- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies

**Contact**: Emergency Manager, City of Beaverton Emergency Management
**Address**: 20665 SW Blanton St. Aloha, OR, 97007
**Phone**: (503) 642-0383
**Website**: www.ci.beaverton.or.us/departments/emergency/
**Email**: emergmngmail@ci.beaverton.or.us

### Engineering Department

The Engineering Department's mission is to provide excellent engineering and construction support services to the citizens and administration of the City of Beaverton in the areas of capital improvements and modifications to the City infrastructure, traffic and transportation and water system operation and maintenance.

**Contact**: Director, Department of Engineering
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2269
**Website**: www.ci.beaverton.or.us/departments/engineering/
**Email**: engmail@ci.beaverton.or.us

### Community Development Department

The Community Development Department consists of the Administration, Building, Development Services, GIS and Planning Services Divisions. The functions of the department include Community Planning, administration of the Community Development Code as it relates to Land Development, Building Plan Review and Inspections, and Customer Service.[33]

**Contact**: Director, Community Development Department
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2493
**Website**: http://www.ci.beaverton.or.us/departments/cdd
**Email**: cddmail@ci.beaverton.or.us

### Operations and Maintenance Department

The Operations Department is responsible for providing a wide variety of maintenance activities to ensure the long-term integrity of the City's infrastructure. Maintenance activities include:

- City Landscapes & Trees
- Roadways
- Pedestrian/Bike Paths
- Traffic Signals
- Streetlights
- Underground Storm Drainage Pipes
- Water Quality Facilities
- Underground Sanitary Sewer Pipes
- City Facilities
- City Vehicles & Equipment

**Contact**: Operations Director
**Address**: 9600 SW Allen Boulevard, Beaverton, OR 97005
**Phone**: (503) 526-2220
**Website**: http://www.ci.beaverton.or.us/departments/operations/
**Email**: opsmail@ci.beaverton.or.us

### Finance Department

The Information Systems Department is part of the Finance Department and includes GIS Services.

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

## County Resources

### Washington County Community Development Code (WCCDC)

The following sections in the Washington County Community Development Code relate to landslide reduction by requiring reports or landscaping to reduce the occurrence of landslides.

- WCCDC Section 404 Master Planning

- WCCDC Section 410 Grading and Drainage
- WCCDC Section 426 Erosion Control

**Contact:** Washington County Land Use and Transportation Department
**Address:** Washington County Land Development Services Division, 155 N. First Avenue, Suite 350, Hillsboro, OR 97124
**Phone**: (503) 846-8761
**Fax**: (503) 846-2908
**Website**: http://www.co.washington.or.us/deptmts/lut/plan99/
**Email:** lutplan@co.washington.or.us

### Office of Consolidated Emergency Management

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff.

Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact:** Director, Washington County Emergency Management
**Address:** 20665 SW Blanton St. Aloha, OR, 97007
**Phone:** (503) 642.0371
**Website:** http://www.ocem.org
**Email:** info@ocem.org

## State Resources

### Department of Land Conservation and Development (DLCD)

Oregon's Department of Land Conservation and Development administers a natural hazards program to assist local governments in meeting statewide Planning Goal 7: Areas Subject to Natural Disasters and Hazards. Activities relating to landslide mitigation include:

- Distribution of model ordinances through which hazards can be mitigated. DLCD advises local governments on which ordinance best meets their needs;
- Reviewing local land use plan amendments for consistency with state landslide programs and regulations and providing direct technical assistance;

- Providing a liaison between pertinent local, state, and federal agencies. DLCD representatives serve on a variety of commissions and ad hoc committees which deal with natural hazards;
- Adopting and amending statewide planning goals and administrative rules relating to natural hazards.

**Contact:** State Floodplain Manager, Natural Hazards Program Manager
**Address:** 635 Capitol Street NE, Suite 150
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

### Oregon Department of Forestry (ODF)

The mission of the Oregon Department of Forestry is to serve the people of Oregon through the protection, management, and promotion of a healthy forest environment, which will enhance Oregon's livability and economy for today and tomorrow. ODF regulates forest operations to reduce the risk of serious injury or death from rapidly moving landslides related to forest operations, and assists local governments in the siting review of permanent dwellings on and adjacent to forestlands in further review areas.

**Contact:** Oregon Department of Forestry, Northwest Oregon
**Address:** 801 Gales Creek Road, Forest Grove, Oregon 97116-1199
**Phone:** (503) 359-7448
**Website:** http://www.odf.state.or.us

#### *Oregon Department of Forestry Debris Flow Warning Page*

The ODF debris flow warning page provides communities with up-to-date access to information regarding potential debris flows. As the lead agency, ODF is responsible for forecasting and measuring rainfall from storms that may trigger debris flows. Advisories and warnings are issued as appropriate. Information is broadcast over NOAA weather radio and on the Law Enforcement Data System. DOGAMI provides additional information on debris flows to the media that convey the information to the public. ODOT also provides warnings to motorists during periods determined to be of highest risk for rapidly moving landslides along areas on state highways with a history of being most vulnerable. Information is available on the ODF website at www.odf.state.or.us.

### Oregon Department of Geology and Mineral Industries (DOGAMI)

DOGAMI is an important agency for landslide mitigation activities in Oregon. Some key functions of DOGAMI are development of geologic data, producing maps, and acting as lead regulator for mining and drilling for geological resources. The agency also provides technical resources for communities and provides public education on geologic hazards. DOGAMI provides data and geologic information to local, state, and federal natural resource agencies, industry, and private groups.

**Contact:** DOGAMI
**Address:** 800 NE Oregon Street, Suite 965, Portland, Oregon 97232
**Phone:** (503) 731-4100
**Fax:** (503) 731-4066
**Website:** http://sarvis.dogami.state.or.us
**Email:** info@naturenw.org

### Nature of the Northwest

Oregon Department of Geology and Mineral Industries and the USDA Forest Service jointly operate the Nature of the Northwest Information Center. The Center offers a selection of maps and publications from state, federal, and private agencies.

**Contact:** The Nature of the Northwest Information Center
**Address:** 800 NE Oregon Street #5, Suite 177, Portland, Oregon 97232
**Phone:** (503) 872- 2750
**Fax:** (503) 731-4066
**Website:** http://www.naturenw.org
**Email:** Nature.of.Northwest@state.or.us

### Oregon Department of Transportation (ODOT)

ODOT provides warnings to motorists during periods determined to be of highest risk of rapidly moving landslides along areas on state highways with a history of being most vulnerable to rapidly moving landslides. ODOT also monitors for landslide activity and responds to slide events on state highways.

**Contact**: ODOT Transportation Building
**Address**: 355 Capitol St. NE, Salem, OR 97310
**Phone**: (888) 275-6368
**Website**: http://www.odot.state.or.us

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

OEM coordinates state resources for rapid and effective response to rapidly moving landslide and other landslide-related emergencies. The Oregon Emergency Response System (OERS) of OEM is a key player in the dissemination of debris flow advisories and warnings. OEM chairs a group that develops and measures landslide hazard mitigation strategies. OEM also administers the FEMA Hazard Mitigation Grant Program, which provides a source of funding for implementing hazard mitigation projects. OEM also works with other state agencies to develop information for local governments and the public on landslide hazards.

**Contact:** Oregon Emergency Management
**Address:** 595 Cottage Street NE
**Phone:** (503) 378-2911
**Fax:** (503) 588-1378
**Website:** http://www.osp.state.or.us/oem

### Portland State University, Department of Geology

Portland State University conducts research and prepares inventories and reports for communities throughout Oregon. Research and projects conducted through the Department of Geology at Portland State University include an inventory of landslides for the Portland metropolitan region after the 1996 and 1997 floods and a subsequent susceptibility report and planning document for Metro in Portland.

**Contact:** Portland State University, Department of Geology
**Address:** 17 Cramer Hall; 1721 SW Broadway, Box 751, Portland, OR 97207
**Phone:** (503) 725-3389
**Website:** http://www.geol.pdx.edu

## Federal Resources

### Federal Emergency Management Agency, landslide fact sheet

FEMA's website contains information on strategies to reduce risk and prevent loss from landslides and debris flows.

**Contact:** Federal Regional Center, Region 10
**Address:** 130-228th St. SW, Bothell, WA 98021-9796
**Phone:** (425) 487-4678
**Website:** http://www.fema.gov/library/landslif.htm

### Natural Resource Conservation Service (NRCS)

The NRCS produces soil surveys. These may be useful to local governments who are assessing areas with potential development limitations including steep slopes and soil types. They operate many programs dealing with the protection of natural resources.

**Contact:** NRCS, Oregon Branch
**Address:** 101 S.W. Main Street, Suite 1300, Portland, OR 97204
**Phone:** (503) 414-3200
**Fax:** (503) 414-3103
**Website:** http://www.or.nrcs.usda.gov

### US Geological Survey, National Landslide Information Center (NLIC)

The NLIC website provides good information on the programs and resources regarding landslides. The page includes information on the National Landslide Hazards Program Information Center, a bibliography, publications, and current projects. USGS scientists are working to reduce long-term losses and casualties from landslide hazards through better understanding of the causes and mechanisms of ground failure both nationally and worldwide.

**Contact:** National Landslide Information Center
**Phone:** (800) 654-4966
**Website:** http://landslide.usgs.gov

## Additional Resources

### American Planning Association (APA)

The APA's research department embarked on a program to bring together solutions from multiple disciplines into a single source. It will help serve local planning efforts in identifying landslide hazards during the planning process so as to minimize exposure to landslide risks. The

APA's website highlights planning efforts to reduce risk and loss from landslides.

**Contact:** Principal Investigator, Landslides Project
**Address:** Research Department, American Planning Association
122 S. Michigan Ave., Suite 1600
Chicago, Illinois 60603-6107
**Phone:** (312) 431-9100
**Fax:** (312) 431-9985
**Website:** http://www.planning.org/landslides
**Email:** landslides@planning.org

### American Red Cross

The American Red Cross is a humanitarian organization, led by volunteers, that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area, including disaster planning, preparedness, and education.

**Contact:** American Red Cross, Oregon Trail Chapter
**Address:** P.O. Box 3200, Portland, OR 97208-3200
**Phone:** (503) 284-1234
**Fax:** (503) 284-4247
**Website:** http://www.redcross-pdx.org
http://www.redcross.org/services/disaster/keepsafe/volcano.html
**Email**: info@redcross-pdx.org

### Institute for Business & Home Safety (IBHS)

IBHS was created as an initiative of the insurance industry to reduce damage and losses caused by natural disasters. Their website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

**Contact**: Institute for Business and Home Safety
**Address**: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
**Phone**: (813) 286-3400
**Fax**: (813) 286-9960
**E-mail**: info@ibhs.org
**Website:** http://www.ibhs.org/ibhs2

### State of Washington, Department of Ecology

The Washington State Department of Ecology has a landslide website with tips for reducing risk, warning signs, and maps.

**Contact:** Department of Ecology
**Address:** PO Box 47600, Olympia, WA 98504-7600
**Website:** http://www.ecy.wa.gov/programs/sea/landslides
**Email:** hshi461@ecy.wa.gov

## Publications

*Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. You can write, call, fax, or go on-line to obtain this document.

**Contact:** Natural Hazards Program Manager, DLCD
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

Mileti, Dennis*, Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press.

This book offers a way to view, study, and manage hazards in the United States that will help foster disaster-resilient communities, higher environmental quality, inter- and intragenerational equity, economic sustainability, and an improved quality of life. The volume provides an overview of what is known about natural hazards, recovery, and mitigation; reveals how research findings have been translated into policies and programs; and advances a sustainable hazard mitigation research agenda.

Olshansky, Robert B., *Planning for Hillside Development* (1996) American Planning Association.

This document describes the history, purpose, and functions of hillside development and regulation and the role of planning, and provides excerpts from hillside plans, ordinances, and guidelines from communities throughout the US.

Olshansky, Robert B. & Rogers, J. David, *Unstable Ground: Landslide Policy in the United States* (1987) Ecology Law Quarterly.

This is about the history and policy of landslide mitigation in the US.

*Public Assistance Debris Management Guide* (July 2000) Federal Emergency Management Agency

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Guide is available in hard copy or on the FEMA website.

**Contact:** FEMA Distribution Center
**Address**: 130 228th Street, SW, Bothell, WA 98021-9796
**Phone:** (800) 480-2520
**Website:** http://www.fema.gov/r-n-r/pa/dmgtoc.htm

*USGS Landslide Program Brochure*. National Landslide Information Center (NLIC), United States Geologic Survey

The brochure provides good, general information in simple terminology on the importance of landslide studies and a list of databases, outreach, and exhibits maintained by the NLIC. The brochure also includes information on the types and causes of landslides, rockfalls, and flows.

**Contact**: USGS- MS 966, Box 25046
**Address**: Denver, Federal Center, Denver, CO 80225
**Phone**: (800) 654-4966
**Web**: http://geohazards.cr.usgs.gov/

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## Landslide Endnotes

[1] Mileti, Dennis*, Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press, Washington D.C.
[2] Brabb, E.E., and B.L Harrod. (Eds) *Landslides: Extent and Economic Significance. Proceedings of the 28th International Geological Congress Symposium on Landslides.* (1989) Washington D.C., Rotterdam: Balkema.
[3] *USGS Landslide Program Brochure,* National Landslide Information Center, United States Geologic Survey.
[4] Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.
[5] Ibid.
[6] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 5.
[7] Robert Olson Associates, *Metro Regional Hazard Mitigation Policy and Planning Guide* (June 1999) Metro.
[8] Ibid.
[9] *Homeowner's Guide for landslide control, hillside flooding, debris flows, soil erosion,* (March 1997).
[10] *Storm Impacts and Landslides of 1996 Final Report* (1999) Oregon Department of Forestry.
[11] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 5.
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[13] *The Citizens' Guide to Geologic Hazard* (1993) American Institute of Professional Geologists, American Institute of Professional Geologists.
[14] Washington County Development Standards, 410-3.3 Grading and Drainage.
[15] *Regional All Hazard Mitigation Master Plan for Clackamas County* (February 1998) Goettel & Associates.
[16] Ibid.
[17] Burby, R. (Ed.) *Cooperating with Nature* (1998) Washington D.C.: Joseph Henry Press.

[18] *Washington County Hazard Analysis* (May 2000) Washington County Emergency Management.
[19] Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.
[20] Burby, R. (Ed.) *Cooperating with Nature.* (1998) Washington D.C.: Joseph Henry Press.
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[22] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/emergency/emergency_eoc.html, (Accessed 4/30/03) (Entire Paragraph)

[23] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/emergency/emergency_errp.html, (Accessed 4/30/03) (Entire Paragraph)

[24] Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.
[25] *Western Oregon Debris Flow Hazard Maps: Methodology and Guidance for Map Use* (1999) Department of Geology and Mineral Industries/Oregon Department of Forestry.
[26] Ibid.
[27] Ibid.
[28] Ibid.
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[30] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Chapter 5.
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[32] *Landslide Hazards and Planning, Guidebook Draft Table of Contents,* (July 2001) American Planning Association.
[33] City of Beaverton Web Page, http://www.ci.beaverton.or.us/departments/cdd/, (Accessed 5/2/03) (Entire Paragraph)

# Chapter 10
# Wildfire

## Table of Contents

## Why are Wildfires a threat to Beaverton?

Fires are a natural part of the ecosystem in Oregon, but they present a substantial hazard when they threaten life and property in growing communities. Although wildfires are more common to the arid areas of Eastern Oregon, there is still potential for loss due to wildland-urban interface fires in Beaverton, especially as the City annexes outlying lands. Wildfire is defined as any fire occurring on wildlands that requires suppression response.[1] The wildfire hazard is often characterized by an increased fire risk in the urban interface zone. The interface is area at the urban-rural fringe where homes and other structures are built into a densely forested or natural landscape. If left unchecked, it is likely that fires in these areas will threaten lives and property.

> *"The heightened awareness of the 2000 fire season attracted an unprecedented commitment from Congress to protect communities, watersheds, and species at risk, and will make fire management a top federal priority for years to come."*
>
> The Nature Conservancy Magazine - May/June 2001

While Beaverton has not been impacted by historic wildfire events to date, wildfire has caused substantial destruction to nearby Oregon communities. In 1990, Bend's Awbrey Hall Fire destroyed 21 homes, causing approximately $9 million in damage and costing over $2 million to suppress, and became one of Oregon's most destructive fires in recent history. In 1996, Bend's Skeleton Fire burned over 17,000 acres and damaged or destroyed 30 homes and structures. In that same year, 218,000 acres were burned, 600 homes were threatened, and 44 homes were lost statewide.[2]

Table 10.1 lists major fires that occurred in Oregon from 1848 to2002.

**Table 10.1. Historic Fires in Oregon (1848-2002)**

| Year | Fire | # of acres burned |
|---|---|---|
| 1848 | Nestucca | 290,000 |
| 1849 | Siletz | 800,000 |
| 1853 | Yaquina | 482,000 |
| 1865 | Silverton | 988,000 |
| 1868 | Coos Bay | 296,000 |
| 1933 | Tillamook | 240,000 |
| 1936 | Bandon | 143,000 |
| 1939 | Saddle Mountain | 190,000 |
| 1945 | Wilson River/Salmonberry | 180,000 |
| 1951 | North Fork/Elkhorn | 33,000 |
| 1966 | Oxbow | 44,000 |
| 1987 | Silver | 970,000 |
| 1992 | Lone Pine | 31,000 |
| 1996 | Skelton | 17,000 |
| 2002 | Biscuit | 500,000 |

Source: "Atlas of Oregon," William G. Loy, et al, University of Oregon Books, 1976. Oregon Department of Forestry, "Tillamook Burn to Tillamook State Forest," revised 1993. Department of Forestry, http://www.odf.state.or.us/DIVISIONS/protection/fire_protection/stats/histfire.asp?id=3070105. Oregon Emergency Management, State Hazard Risk Assessment, 2003.

During the 2000 fire season, more than 7.5 million acres of public and private lands burned in the US, resulting in loss of property, damage to resources, and disruption of community services. Taxpayers spent more than $1.6 billion to combat 90,000 fires nationwide.[3] Many of these fires burned in wildland/urban interface areas and exceeded the fire suppression capabilities of those areas. The magnitude of the year 2000 fires is the result of two primary factors: (1) severe drought, accompanied by a series of storms that produce thousands of lightning strikes and windy conditions; and (2) the effects of wildfire suppression over the past century that has led to buildup of brush and small diameter trees in the nation's forests and rangelands.[4]

Southern Oregon's Biscuit fire burned almost 500,000 acres between July and November of 2002. Fourteen structures were lost including four homes, nine outbuildings, and one lookout, as well as numerous recreation structures. At the fire's peak, some 7,000 firefighters were assigned to the blaze and the cost of the fire fighting effort is estimated at $153,000,000.[5]

Table 10.2 illustrates the fire suppression costs for state, private, and federal lands protected by the Oregon Department of Forestry between 1985 and 2002.

**Table 10.2. History of Fire Suppression Costs 1985-2002**

| Year | Suppression Costs in $$ |
|---|---|
| 1985 | 3,268,644 |
| 1986 | 5,847,018 |
| 1987 | 32,080,746 |
| 1988 | 13,192,596 |
| 1989 | 6,394,593 |
| 1990 | 8,279,974 |
| 1991 | 5,381,192 |
| 1992 | 17,000,000 |
| 1993 | 4,023,033 |
| 1994 | 21,100,000 |
| 1995 | 4,360,349 |
| 1996 | 5,066,227 |
| 1997 | 1,210,692 |
| 1998 | 2,056,343 |
| 1999 | 5,320,555 |
| 2000 | 5,750,862 |
| 2001 | 33,792,483 |
| 2002 | 60,812,872 (preliminary) |

"With more Oregonians than ever living in forests that have grown thicker than ever through decades of strict fire suppression, even modest fires can quickly consume lives, homes, and the millions of dollars it costs to fight them."

The Oregonian,
Feb. 26, 2001

## Wildfire Characteristics

The characteristics of fire are important to understand when trying to mitigate its negative effects on humans and structures. In order for fire to exist, the three components of the fire triangle must be present. The triangle consists of fuel, heat, and oxygen.[6] Most naturally caused fires are initiated by lightning strikes. Human-caused fires, both accidental and deliberate, are produced in many ways, including campfires, chimneys, torches, matches, fireworks, cigarettes, vehicle fires, military ordnance, and smoldering slash piles.[7] In either instance, natural or human-caused, the ignition is started because the fire triangle exists. Fires occurring in natural ecosystems begin as a point of ignition, burn outward into circles and, if they escalate, spread in the direction toward which the wind is blowing.[8] Additionally, when burning occurs on uneven terrain, the fire spreads upslope to eventually form itself into broad ellipses.[9]

Effects of fire on ecosystem resources can represent damages, benefits, or some combination of both, depending largely on the characteristics of the fire site, the severity of the fire, the time period of valuation, and the values placed on the resources affected by the fire.[10] The ecosystems of most forests depend upon fire to maintain various functions. The use of fire for beneficial purposes is considered, where appropriate, in terms of reducing fuel loads, disposing of slash, preparing seedbeds, thinning overstocked stands, increasing forage plant production, improving wildlife habitats, changing hydrologic processes, and improving aesthetic environments.[11] However, despite its beneficial values to ecosystems, fire has been suppressed for years because of its perceived effects on timber harvest and threat to human life. In addition, new development continues to push its way into what is termed as the "wildland-urban interface."

### The Interface

There are three categories of interface fire:[12]

- The classic wildland-urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas;
- The mixed wildland-urban interface is characterized by isolated homes, subdivisions, and small communities situated predominantly in wildland settings; and
- The occluded wildland-urban interface exists where islands of wildland vegetation occur inside a largely urbanized area.[13]

The occluded wildland-urban interface is the most probable interface fire that would occur in Beaverton.

Unlike most other natural hazards, the wildland-interface is not designated by geography alone. Certain conditions must be present for significant interface fires to occur. The most common are hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation).[14] Once a fire has started, several conditions influence its behavior, including fuel, topography, weather, drought, and development. These combined conditions are the key elements that add to increased wildfire risk. The severity of the wildfire is ultimately affected by the severity of these conditions. For example, if a steep slope (topography) is combined with extremely low humidity, high winds, and highly flammable vegetation, then a high–intensity wildfire may develop.

Since the 1970s, Oregon's growing population has expanded further and further into traditional resource lands such as forestland. The "interface" between urban and suburban areas and the resource lands created by this expansion has produced a significant increase in threats to life and property from fires, and has pushed existing fire protection systems beyond original or current design or capability.[15] Property owners in the interface are often unaware of the problems and threats they face. Therefore, many owners have done very little to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

### Fuel[16]

Fuel is the material that feeds a fire, and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading," or the amount of available vegetative fuel. The type of fuel refers to the species of trees, shrubs, and grass that are present. Oregon, as a western state with prevalent conifer, brush, and rangeland fuel types, is subject to more frequent wildfires than other regions of the nation.

An important element in understanding the danger of wildfire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures, and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. After decades of fire suppression, "dog-hair" thickets have accumulated. These enable high intensity fires to flare and spread rapidly. Structures that are made of combustible material such as shake roofs and wood siding are especially susceptible to fire. Untrimmed bushes near these structures often serve as "ladder fuels" – enabling a slow moving ground fire to climb onto rooftops and into the crowns of trees. A crown fire is significantly more difficult to suppress than a ground fire, and are much more threatening to structures in the interface. Wildfire at the upper end of the wildfire intensity spectrum is likely to spread into the tops of the tallest trees in violent and discontinuous surges.[17] Fire that occurs at this severe end of the spectrum responds to its own convective winds, spreading rapidly as sparks from exploding trees ignite other fires many meters away.[18]

Because of the many different possible "fuels" found in the interface landscape, firefighters have a difficult time predicting how fires will react or spread.

### Topography[19]

Topography influences the movement of air, thereby directing a fire's course. For example, if the percentage of uphill slope doubles, the rate of spread in wildfire will likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces upslope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildfire hazard mitigation and increased education and outreach to homeowners living in interface areas.

### Weather[20]

Weather patterns combined with certain geographic locations can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible.[21] High-risk areas in Oregon share a hot, dry season in late summer and early fall when high temperatures and low humidity favor fire activity. Predominant wind directions may guide a fire's path. In addition, many high intensity fires produce their own wind, which aids in the spread of fire.

### Drought

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. The term *drought* is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions, and leave reservoirs and water tables lower. Drought leads to problems with irrigation, and may contribute to additional fires, or additional difficulties in fighting fires. However, most fuel types (not including grasses) require two or three years of drought before the fuel becomes dangerously dry. Drought contributes to the frequency and intensity of fires. A February 2001Oregonian article reported: "Favorable weather last year helped the Northwest emerge largely unscathed from a fire season that scorched other parts of the West. But the forests remain thick with timber and with homes. And this winter has brought the Northwest far less snow and rain than usual, which could give a greater foothold to the flames that are sure to come."[22] And surely flames came to the state during the 2002 fire season.

### Development

Growth and development in forested areas is increasing the number of human-caused structures in the interface in Oregon. Wildfire has an effect on development, yet development can also influence wildfire. While wildfires have always been a historic part of the ecosystem in Oregon, homes in the interface often lead to human ignition of fire. The combined increase in human development and activity in the interface, with the high content of fuels from years of fire suppression, can create a lethal combination.

Homeowners often prefer lots that are private and have scenic views nestled in vegetation. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and firefighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself. [23]

## Community Wildfire Issues

### Characteristics of Growth and Development in the Interface

People living in or near wildland settings in Beaverton are vulnerable to the threat of wildfire. While there is currently very little wildland interface within the City of Beaverton's jurisdiction, some of the City's annexable land to the southwest and northeast possess some of the characteristics that define the interface zone. As Beaverton continues to grow, the wildland interface will become an increased concern for the City. The vegetation in these interface areas consists of an assortment of grasses, shrubs, and deciduous and coniferous trees. Steep slopes may also be a consideration in determining wildfire prone areas in future annexation. The development of homes and other structures is encroaching into wildland and natural areas and is expanding the wildland-urban interface. Interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation, and natural fuels.

In the event of a wildfire, vegetation, structures, and other flammables can merge into unwieldy and unpredictable events. Factors germane to the fighting of such fires include access, firebreaks, proximity of water sources, distance from fire stations, and available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged by wildfire for one or more of the following reasons:[24]

- Combustible roofing material;
- Wood construction;
- Structures with no defensible space;
- Fire department with poor access to structures;
- Subdivisions located in heavy natural fuel types;
- Structures located on steep slopes covered with flammable vegetation;
- Limited water supply; and
- Winds over 30 miles per hour.

### Road Access

Of particular concern to firefighters are developments with narrow roadways and few routes of egress, or routes with very limited accessibility. Many new subdivisions are constructed with cul-de-sacs, which contribute to the problem of road access. Most cul-de-sacs do not allow rear access to homes, which can be a significant problem for firefighters and emergency services in defending the structure and ensuring the safety of its inhabitants.

### Water Supply

Water supply is a critical factor in the ability to fight wildland fires. Developments lacking an adequate water supply and hydrant taps create extra challenges for firefighting personnel. Another water supply issue is that of small diameter pipe water systems, which are inadequate to provide sustained fire-fighting flows.

# Wildfire Hazard Assessment

## Wildfire Hazard Identification

Hazard identification is the first phase of a hazard assessment, and is the process of estimating the geographic extent of the hazard, its intensity, and its probability of occurrence.[25] This process usually results in a hazard map. Hazard maps can provide detailed information in a clear format to the public and to policy and land use decisions makers.

Wildfire hazard areas are commonly identified in regions of the wildland/urban interface. Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control, such as the surrounding fuel load, weather, topography, and property characteristics. Generally, hazard identification rating systems are based on weighted factors of fuels, weather, and topography. Indicators of least dangerous to most dangerous illustrate each category. For example:

| | |
|---|---|
| *Roads and Signage* | |
| Steep; narrow; poorly signed | 3 |
| One or two of the above | 2 |
| Meets all requirements | 1 |
| *Water Supply* | |
| None, except domestic | 3 |
| Hydrant, tank, or pool over 500 feet away | 2 |
| Hydrant, tank, or pool within 500 feet | 1 |
| *Location of the Structure* | |
| Top of steep slope with brush/grass below | 3 |
| Mid-slope with clearance | 2 |
| Level with lawn, or watered groundcover | 1 |

In order to determine the "base hazard factor" of specific wildfire hazard sites and interface regions, several factors must be taken into account. Categories used to assess the base hazard factor include:

- Topographic location, characteristics, and fuels;
- Site/building construction and design;
- Site/region fuel profile (landscaping);
- Defensible space;
- Accessibility;
- Fire protection response; and
- Water availability.

The use of Geographic Information System (GIS) technology in recent years has been a great asset to fire hazard assessment, allowing further integration of fuels, weather, and topography data for such ends as fire behavior prediction, watershed evaluation, mitigation strategies, and hazard mapping. As stated in the wildfire characteristics section of this chapter, the interface is not geographic in nature, but is associated with certain characteristics such as slope and vegetation. Based on these characteristics there are potential interface areas in Beaverton's current annexable lands. Data at the time of publication was not comprehensive enough to make a determination on which lots were at risk. As development occurs to the northeast and the southwest, the issue of wildfire will need to be addressed.

## Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through hazard identification with an inventory of the existing development exposed to wildfire. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.[26] Data that includes the location of interface areas in the City can be used to assess the population and total value of property at risk from wildfire.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for Beaverton wildfire events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. There are many pockets of forested land scattered throughout the City. Whether lying in undeveloped areas or alongside heavily developed commercial or residential properties, these lands pose a significant wildland/urban interface fire threat. Although the City has no history of fires rising to the level of major emergency or disaster, the potential will increase as development near these hazard areas becomes more concentrated.

## Risk Analysis

Risk analysis is the third, and most advanced phase of a hazard assessment. It builds upon hazard identification and vulnerability assessments.

Key factors included in assessing wildfire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence, and weather, as well as occurrences of drought. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

> ***Long-Term Wildfire Action Item #1:***
> Encourage creation and adoption of wildland interface maps to build development requirements that assist wildfire mitigation.
> *See page 10-19 for more information.*

The National Wildland/Urban Fire Protection Program has developed a Wildland/Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildfire. For more information on wildfire hazard assessment refer to www.Firewise.org.

# Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Partnerships for Communication and Coordination
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

## Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations.

### Local Programs

#### Tualatin Valley Fire and Rescue (TVFR)

Tualatin Valley Fire and Rescue fire fighting crews are actively working on public education and homeowner responsibility by visiting neighborhoods and explaining hazards to citizens. They hand deliver informative brochures and encourage citizens to clearly mark their address on the roadway to ensure more rapid and accurate response to calls and better access. The District has identified urban/wildland interface areas using criteria outlined by the Department of Forestry. The District crews hope to conduct community meetings in the future to further reach out to their constituents and personally inform them of wildfire hazard mitigation strategies.

### Regional Programs

#### Building Codes

City, county, state, and local jurisdictions work together to establish and ultimately implement building codes. These codes apply to new development, dwellings and structures, retrofitting, and siting. The process begins with the establishment of the code at the state level, and is then implemented locally. For example, once the State of Oregon establishes a building code, the City of Beaverton implements the code for its residents. Some fire mitigation standards covered by codes are: Locating in a fire protection district or ensuring fire protection through contract;

- Identification of water supply;
- Provision of adequate road access;
- Establishing fire breaks;
- Meeting slope requirements;

- Using fire retardant roofs; and
- Installing spark arresters on chimneys.

## State Programs

### Oregon Revised Statute 215.730:

For more information on forestland zones consult the Oregon Department of Land Conservation and Development; Statewide Goal 4 – Forestlands and Oregon Administrative Rules 660-006.

ORS 215.730, Additional Criteria for Forestland Dwellings, provides criteria for approving dwellings located on lands zoned for forest and mixed agriculture/forest use. Under its provisions, county governments must require, as a condition of approval, that single-family dwellings on lands zoned as forestland meet the following requirements:

1. Dwelling has a fire retardant roof;
2. Dwelling will not be sited on a slope of greater than 40 percent;
3. Evidence is provided that the domestic water supply is from a source authorized by the Water Resources Department and not from a Class II stream as designated by the State Board of Forestry;
4. Dwelling is located upon a parcel within a fire protection district or is provided with residential fire protection by contract;
5. If dwelling is not within a fire protection district, the applicant provides evidence that the applicant has asked to be included in the nearest such district;
6. If dwelling has a chimney or chimneys, each chimney has a spark arrester; and
7. Dwelling owner provides and maintains a primary fuel-free break and secondary break areas on land surrounding the dwelling that is owned or controlled by the owner.

If a governing body determines that meeting the fourth requirement is impractical, local officials can approve an alternative means for protecting the dwelling from fire hazards.

### Oregon Revised Statute 477.015-061

Provisions in ORS 477.015-061, Urban Interface Fire Protection, were established through efforts of the Oregon Department of

Forestry, the Office of the State Fire Marshal, fire service agencies from across the state, and the Commissioners of Deschutes, Jefferson, and Jackson Counties. It is innovative legislation designed to address the expanding interface wildfire problem within Oregon Department of

Forestry Fire Protection Districts. Full implementation of the statute will occur on or after January 1, 2002. The statute does the following:

1. Directs the State Forester to establish a system of classifying forestland-urban interface areas;
2. Defines forestland-urban interface areas;
3. Provides education to property owners about fire hazards in forestland-urban interface areas. Allows for a forestland- urban interface county committee to establish classification standards;
4. Requires maps identifying classified areas to be made public;
5. Requires public hearings and mailings to affected property owners on proposed classifications;
6. Allows property owners appeal rights;
7. Directs the Board of Forestry to promulgate rules that set minimum acceptable standards to minimize and mitigate fire hazards within forestland-urban interface areas; and
8. Creates a certification system for property owners meeting acceptable standards. Establishes a $100,000 liability limit for cost of suppressing fires, if certification requirements are not met.

***478.120 Inclusion of forestland in district.*** The authority to include forestland within a rural fire protection district pursuant to ORS 478.010 (2)(c) applies to forestland within the exterior boundaries of an existing district and to forestland on which structures subject to damage by fire have been added after July 20, 1973.

***478.140 Procedure for adding land to district by consent of owner.*** Any owner consenting to add the forestland of the owner to the district under ORS 478.010 (2)(c) shall do so on forms supplied by the Department of Revenue. The owner shall file the original with the district. The district shall forward a copy to the assessor of each county in which the land is located, within 20 days of receipt.

***478.910 Adoption of fire prevention code.*** A district board may, in accordance with ORS 198.510 to 198.600, adopt a fire prevention code.

***478.920 Scope of fire prevention code.*** The fire prevention code may provide reasonable regulations relating to:

(1) Prevention and suppression of fires.

(2) Mobile fire apparatus means of approach to buildings and structures.

(3) Providing fire-fighting water supplies and fire detection and suppression apparatus adequate for the protection of buildings and structures.

(4) Storage and use of combustibles and explosives.

(5) Construction, maintenance and regulation of fire escapes.

(6) Means and adequacy of exit in case of fires and the regulation and maintenance of fire and life safety features in factories, asylums, hospitals, churches, schools, halls, theaters, amphitheaters, all buildings, except private residences, which are occupied for sleeping purposes, and all other places where large numbers of persons work, live, or congregate from time to time for any purpose.

(7) Requiring the issuance of permits by the fire chief of the district before burning trash or waste materials.

(8) Providing for the inspection of premises by officers designated by the board of directors, and requiring the removal of fire hazards found on premises at such inspections.

***478.927 Building permit review for fire prevention code.*** A district adopting a fire prevention code shall provide plan review at the agency of the city or county responsible for the issuance of building permits for the orderly administration of that portion of the fire prevention code that requires approval prior to the issuance of building

### Senate Bill 360

Senate Bill 360, passed in 1997, is state legislation put in place to address the growing wildland/urban interface problem. The bill has three purposes:

1. To provide an interface fire protection system in Oregon to minimize cost and risk and maximize effectiveness and efficiency;
2. To promote and encourage property owners' efforts to minimize and mitigate fire hazards and risks; and
3. To promote and encourage involvement of all levels of government and the private sector in interface solutions.[27]

The bill has a five-year implementation plan that includes public education and outreach, and the development of rules, standards, and guidelines that address landowner and agency responsibilities. The success of Senate Bill 360 depends upon cooperation among local and regional fire departments, fire prevention cooperatives, and the Oregon Department of Forestry, which means interagency collaboration is vital for successful implementation of the bill. This cooperation is important in all aspects of wildland firefighting. Resources and funding are often limited, and no single agency has enough resources to tackle a tough fire season alone. The introductory language of Senate Bill 360 states: "The fire protection needs of the interface must be satisfied if we are to meet the basic policy of the protection of human life, natural resources, and personal property. This protection must be provided in an efficient and effective manner, and in a cooperative partnership approach between property owners, local citizens, government leaders, and fire protection agencies."

### Oregon Department of Forestry

ODF is involved with local fire chiefs and local fire departments to provide training. Local firefighters can get a range of experience from exposure to wildland firefighting. Local firefighters can also obtain their red card (wildland fire training documentation), and attend extensive workshops combining elements of structural and wildland firefighting, defending homes, and operations experience. [28]

ODF has been involved with emergency managers to provide support during non-fire events and for years, ODF has worked with industrial partners (big timber companies) to share equipment in the case of extremely large fires. [29]

### Federal Programs

The proposed role of the federal land managing agencies, such as the U.S. Forest Service and the Bureau of Land Management, in the wildland/urban interface is diverse. Their roles include: reducing fuel hazards on the lands they administer; cooperating in prevention and education programs; providing technical and financial assistance; and developing agreements, partnerships, and relationships with property owners, local protection agencies, states, and other stakeholders in wildland/urban interface areas. These relationships focus on activities before a fire occurs, which render structures and communities safer and better able to survive a fire occurrence. [30]

> *"New data from National Forest Service fire ecologists shows that for every dollar spent on prescribed burning, forest thinning and the training of fire-management personnel, seven dollars worth of savings are realized in the costs of having to extinguish big fires. When that ratio is placed in the context of an average $1 billion spent annually over the past decade on fire suppression, the implications of foresighted fire management are profound."*
>
> The Nature Conservancy Magazine – May/June 2001

#### Federal Emergency Management Agency Programs

The Federal Emergency Management Agency (FEMA) is directly responsible for providing fire suppression assistance grants and, in certain cases, major disaster assistance and hazard mitigation grants in response to fires. The role of FEMA in the wildland/urban interface is to encourage comprehensive disaster preparedness plans and programs, increase the capability of state and local governments, and provide for a greater understanding of FEMA's programs at the federal, state, and local levels.[31]

### Fire Suppression Assistance Grants

Fire Suppression Assistance Grants may be provided to a state with an approved hazard mitigation plan for the suppression of a forest or grassland fire that threatens to become a major disaster on public or private lands. These grants are provided to protect life and improved property, and encourage the development and implementation of viable multi-hazard mitigation measures, and provide training to clarify FEMA's programs. The grant may include funds for equipment, supplies, and personnel. A Fire Suppression Assistance Grant is the form of assistance most often provided by FEMA to a state for a fire. The grants are cost-shared with states. Once the federal grant money is provided to the State, it is then passed along to local jurisdictions. This money would ultimately be passed along to the City of Beaverton to be applied to projects. FEMA's US Fire Administration (USFA) provides public education materials addressing wildland/urban interface issues, and the USFA's National Fire Academy provides training programs.[32]

> States must have an approved hazard mitigation plan in place to receive either a Fire Suppression Assistance Grant or a Hazard Mitigation Grant.

### Hazard Mitigation Grant Program

Following a major disaster declaration, the FEMA Hazard Mitigation Grant Program provides funding for long-term hazard mitigation projects and activities to reduce the possibility of damages from all future fire hazards and to reduce the costs to the nation for responding to and recovering from the disaster.

### National Wildland/Urban Interface Fire Protection Program

Federal agencies can use the National Wildland/Urban Interface Fire Protection Program to focus on wildland/urban interface fire protection issues and actions. The Western Governors' Association (WGA) can act as a catalyst to involve state agencies, as well as local and private stakeholders, with the objective of developing an implementation plan to achieve a uniform, integrated national approach to hazard and risk assessment and fire prevention and protection in the wildland/urban interface. The program helps states develop viable and comprehensive wildland fire mitigation plans and performance-based partnerships.

### US Forest Service

The US Forest Service (USFS) is involved in a fuel-loading program implemented to assess fuels and reduce hazardous buildup on US forestlands. The USFS is a cooperating agency and, while it does not have jurisdiction in Beaverton city limits, it still has an interest in preventing fires in the interface, as fires often burn up the hills and into the higher elevation US forestlands.[33] This will especially be an important issue as Beaverton annexes land in the wildland-urban interface in the future.

## Other Mitigation Programs and Activities

Some areas of the country are facing wildland/urban issues collaboratively. These are model programs that include local solutions. One example of this is in Ashland, Oregon. Because of the highly flammable slopes above Ashland, homeowners in the wildland urban interface face a high risk of encountering a wildland fire. The City has partnered with local organizations to help coordinate mitigation strategies with homeowners in high-risk areas. Currently, more than 40 acres have been treated in the interface above Ashland.[34] Treatment has included thinning of tree stands, removing of highly flammable noxious weeds (i.e. Scotch broom), and the creation of fuel breaks along ridge tops most susceptible to wildland fire. The City has contributed approximately $500,000 dollars towards cost shares with homeowners to help reduce fuels near their homes.[35] In California, the Los Angeles County Fire Department has retrofitted more than 100 fire engines with fire retardant foam capability, and Orange County is evaluating a pilot insurance grading and rating schedule specific to the wildland/urban interface. Both are examples of successful programs that demonstrate the value of pre-suppression and prevention efforts when combined with property owner support to mitigate hazards within the wildland/urban interface.[36]

### Prescribed Burning

The health and condition of a forest will determine the magnitude of a wildfire. If fuels – slash, dry or dead vegetation, fallen limbs and branches – are allowed to accumulate over long periods of time without being methodically cleared, fire can move more quickly and destroy everything in its path. The results are more catastrophic than if the fuels are periodically eliminated. Prescribed burning is the most efficient method to get rid of these fuels. In 1998, 3,000 prescribed fires were used to burn approximately 163,000 acres statewide.[37]

### Firewise

Firewise is a program developed within the National Wildland/ Urban Interface Fire Protection Program, and it is the primary federal program addressing interface fire. It is administered through the National Wildfire Coordinating Group whose extensive list of participants includes a wide range of federal agencies. The program is intended to empower planners and decision makers at the local level. Through conferences and information dissemination, Firewise increases support for interface wildfire mitigation by educating professionals and the general public about hazard evaluation and policy implementation techniques. Firewise offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences. The interactive home page allows users to ask fire protection experts questions, and to

*For more information on the Firewise program, contact:*
The Wildland/Urban Interface Fire Program
c/o The National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02269 -
http://www.firewise.org

register for new information as it becomes available.

### FireFree Program

FireFree is a unique private/public program for interface wildfire mitigation involving partnerships between an insurance company and local government agencies. It is an example of an effective non-regulatory approach to hazard mitigation. Originating in Bend, the program was developed in response to the city's "Skeleton Fire" of 1996, which burned over 17,000 acres and damaged or destroyed 30 homes and structures.[38] Bend sought to create a new kind of public education initiative that emphasized local involvement. SAFECO Insurance Corporation was a willing collaborator in this effort. Bend's pilot program included:

- A short video production featuring local citizens as actors, made available at local video stores, libraries, and fire stations;
- Two city-wide yard debris removal events;
- A 30-minute program on a model FireFree home, aired on a local cable television station; and
- Distribution of brochures, featuring a property owner's evaluation checklist and a listing of fire-resistant indigenous plants.

> For information on FireFree, contact:
>
> SAFECO Plaza T-8,
> Seattle, WA 98185, (206) 545-6188
> http://www.FireFree.org

The success of the program helped to secure $300,000 in Federal Emergency Management Agency (FEMA) "Project Impact" matching funds. By fostering local community involvement, FireFree also has the potential for building support for sound interface wildfire policy

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# Wildfire Mitigation Action Items

The wildfire mitigation action items provide direction on specific activities that organizations and residents in Beaverton can undertake to reduce risk and prevent loss from wildfire events. There are three long-term wildfire action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

**LT-WF#1 Encourage the creation and adoption of wildland interface maps to build development requirements that assist wildfire mitigation.**

***Ideas for Implementation:***

- Identify and establish a data-collection mechanism in coordination with city, county, state, and local governments, fire agencies, the insurance industry, and the National Fire Protection Association.
- Using collected data and research assess the nature and scope of the wildland/urban interface fire problems in the city.

| | |
|---|---|
| **Coordinating Organization:** | City of Beaverton |
| **Internal Partners:** | ISD/GIS, Emergency Management, Community Development Department |
| **External Partners:** | Department of Land Conservation and Development (DLCD), Washington County, Oregon Department of Forestry (ODF), Office of the State Fire Marshal (OSFM), Tualatin Valley Fire and Rescue District |
| **Timeline:** | 1-5 years |
| **Plan Goals Addressed:** | Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Improve Partnerships for Communication and Coordination |

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**LT-WF#2: Develop and implement, or enhance existing outreach and education programs aimed at mitigating wildfire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners, and businesses to natural hazards.**

***Ideas for Implementation:***

**Outreach**

- Visit urban interface neighborhoods and conduct site assessments, education and outreach activities;
- Conduct specific community-based demonstration projects of fire prevention and mitigation in the urban interface;

- Establish neighborhood "drive-through" activities that pinpoint site-specific mitigation activities. Fire crews can give property owners personal suggestions and assistance; and
- Perform public outreach and information activities at Beaverton fire stations by creating "Wildfire Awareness Week" activities. Fire stations can hold open houses and allow the public to visit, see the equipment, and discuss wildfire mitigation with the station crews.

**Education**

- Encourage communities in the wildland/urban interface to develop public awareness programs and land use development policies that ensure specific recommendations for wildfire mitigation policies, programs, and community-based activities will be implemented; and
- Develop a "preventative approach" campaign by educating the public on hazardous human activities that must be regulated and controlled because of the danger of starting fires, including enforcement of existing "no burn" policy.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Emergency Management, Mayor's Office - Neighborhood Program, Community Development Department
**External Partners:** School Districts, Oregon Emergency Management (OEM), Oregon Department of Forestry (ODF), Firewise, FireFree, Washington County
**Timeline:** Ongoing
**Plan Goals Addressed:** Improve Partnerships for Communication and Coordination; Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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**LT-WF#3: Increase communication, coordination, and collaboration between wildland/urban interface property owners, city and county planners, and fire prevention crews and officials to address inherent risks in wildland/urban interface areas, available prevention/protection measures, and federal mitigation assistance programs.**

***Ideas for Implementation:***

- Encourage zoning and planning entities to work closely with landowners and/or developers in mapped wildland/urban interface areas to identify and mitigate conditions that aggravate wildland/urban interface wildfire hazards, including:
- Limited access for emergency equipment due to width and grade of roadways;
- Inadequate water supplies and the spacing, consistency, and species of vegetation around structures;

- Inadequate fuel breaks, or lack of defensible space;
- Highly flammable construction materials;
- Building lots and subdivisions that are not in compliance with state and local land use and fire protection regulations; and
- Inadequate entry/escape routes.
- Inadequate water pressure for fire suppression.
- Require all new homes and major remodels involving roofs or additions that are located in the interface to have fire resistant roofs.
- Provide education and training to the public to assess if their homes meet fire safety performance standards.
- Encourage the public to evaluate access routes to homes for fire-fighting vehicles and to develop passable routes if they do not exist.
- Review development and building codes to ensure adequate requirements for sprinkler systems, setbacks, etc in identified wildland interface areas.

| | |
|---|---|
| **Coordinating Organization:** | City of Beaverton |
| **Internal Partners:** | Emergency Management, Community Development Department |
| **External Partners:** | Washington County, Oregon Department of Forestry (ODF), Office of the State Fire Marshal, Tualatin Valley Fire and Rescue District |
| **Timeline:** | 1-5 years |
| **Plan Goals Addressed:** | Improve Partnerships for Communication and Coordination, Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Enhance Emergency Services |

# Wildfire Resource Directory

## City Resources

### Emergency Management Program

The City has an Emergency Manager who is part of the Mayor's Office and who is responsible for managing the City's program in all four phases of Emergency Management. Responsibilities of the City's Emergency Manager includes:

- Development and maintenance of the City's Response, Recovery, preparedness, and Mitigation Plans
- Public education and training
- Education and training of City employees

- Establishing procedures to staff and maintain the City's Emergency Operations Center during disasters and emergencies
- Coordination with local, regional, state, and federal jurisdictions and agencies [39]

**Contact:** Emergency Manager, Emergency Management
**Address:** 20665 SW Blanton Street in Aloha
**Phone**: (503) 642-0383
**Website**: http://www.ci.beaverton.or.us/departments/emergency/
**Email:** info@ocem.org

## Community Development Department

The Community Development Department consists of the Administration, Building, Development Services and Planning Services Divisions. The functions of the department include Community Planning, administration of the Community Development Code as it relates to Land Development, Building Plan Review and Inspections, and Customer Service.[40]

**Contact:** Director, Community Development Department
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2493
**Website**: http://www.ci.beaverton.or.us/departments/cdd
**Email:** cddmail@ci.beaverton.or.us

## Neighborhood Program

The Neighborhood Program promotes citizen involvement in city government by:

- Providing support and assistance to the Neighborhood Association Committees (NACs) and Beaverton Committee for Citizen Involvement (BCCI),
- Coordinating recruitment for the City's 14 boards and commissions,
- Developing and sponsoring education and fun events and activities for the public,
- Managing the public's use of the Beaverton Community Center

**Contact:** Program Manager, Neighborhood Program
**Address:** 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone:** (503) 526-2243
**Website:** http://www.ci.beaverton.or.us/departments/neighborhoods
**Email:** neighbormail@ci.beaverton.or.us

## Finance Department

The Information Systems Department is part of the Finance Department and includes GIS Services.

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

## County Resources

### Washington County Building Services Division

The Building Services Division issues a variety of building permits and enforces building codes. It also works on countywide coordination among city building code officials to improve the effectiveness of building inspection during an unscheduled event.

**Contact:** Washington County Building Official
**Address:** Washington County Building Services Division, Land Use and Transportation Department, 155 N. First Avenue, Suite 350-12, Hillsboro, OR 97124
**Phone**: (503) 846-3470
**Fax**: (503) 846-3993
**Website**: http://www.co.washington.or.us/deptmts/lut/ land_dev/bld_ serv.htm

### Office of Consolidated Emergency Management

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff.

Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact:** Director, Washington County Emergency Management
**Address:** 20665 SW Blanton St. Aloha, OR, 97007
**Phone:** (503) 642-0371
**Website:** http://www.ocem.org
**Email:** info@ocem.org

### Washington County Fire Defense Board

The Washington County Fire Defense Board is comprised of all the local fire chiefs within the county and also includes ex-officio representatives from the State Fire Marshal's Office and the Oregon Department of

Forestry. Pursuant to the Oregon Fire Service Mobilization Plan, the Fire Defense Board is charged with the following responsibilities:

- Develop a fire service plan with provisions permitting local departments to respond with mutual aid forces upon request of other local departments in the county.
- Administer the State Fire Mobilization Plan within the county.
- Maintain response procedures for alert, transfer, and dispatch of fire fighting equipment and personnel.
- Maintain liaison with other agencies capable of augmenting fire-fighting resources.
- Maintain inventories of fire fighting equipment in the county.
- Develop dispatch plans for mobilization requests and conduct exercises as necessary to ensure efficient operations.
- Develop expedient procedures for providing and dispatching incident command overhead teams and logistical support.
- Hold regular meetings.

The Washington County Fire Defense Board meets regularly with representatives from a number of other agencies in the county to coordinate prevention and response activities and issues. Those agencies/individuals include the county sheriff's office, Metro West Ambulance, the Washington County Consolidated Communications Agency (County 911), the Washington County Emergency Medical Services Coordinator, Washington County Emergency Management, and the Washington County Building Services Division. For contact information for the Washington County Fire Defense Board, contact the Oregon State Fire Marshal.

**Contact:** Oregon State Fire Marshal
**Address:** 4760 Portland Road NE, Salem, Oregon 97305-1760
**Phone:** (503) 378-3473
**Fax:** (503) 373-1825
**Website:** http://159.121.82.250/
**Email:** oregon.sfm@state.or.us

### Tualatin Valley Fire and Rescue (TVFR)

Tualatin Valley Fire & Rescue provides fire protection and emergency medical services to over 395,000 citizens throughout its 220 square mile jurisdiction. The Fire District's service area includes the cities of Beaverton, Durham, King City, Rivergrove, Sherwood, Tigard, Tualatin, West Linn, and Wilsonville, as well as unincorporated areas within Clackamas, Multnomah, and Washington counties. The District has 23 fire stations, an Administrative Office, a training facility, and three Operating Centers serving specific communities.

**Contact:** Tualatin Valley Fire and Rescue
**Address:** 20665 SW Blanton Street, Aloha, Oregon 97007
**Phone**: (503) 649-8577
**Fax**: (503) 642-4814

**Website**: http://www.tvfr.com

## Regional Resources

### Metro Regional Government

Metro is the directly elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington counties and 24 cities in the Portland metropolitan area. Chapter 5 of Metro's Regional Framework Plan addresses natural hazards. Metro's Natural Hazards Program is a service of the Growth Management Services Department's Data Resource Center. Their web pages relate to natural hazards that may impact the Portland metropolitan area. Their links provide information about the natural hazards in the Portland metropolitan area and suggest tools for reducing potential damages before disaster strikes. Metro produced the *Regional Hazard Mitigation Policy and Planning Guide* in 1999 to assist local governments in planning for future natural hazard events.

**Contact 1:** Metro Regional Government
**Address:** 600 NE Grand Ave, Portland, OR 97232-2736
**Phone:** (503) 797-1839
**Fax:** (503) 797-1911
**Website:** http://www.metro.dst.or.us/metro/growth/gms.html
**Email:** 2040@metro-region.org

**Contact 2:** Metro Data Resource Center
**Website:** http://storefront.metro.dst.or.us/drc/nathaz/nathaz.cfm
**Email:** drc@metro.dst.or.us

## State Resources

### Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to natural hazards, with flood as its major focus. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance such as conducting workshops, reviewing local land use plan amendments, and working interactively with other agencies.

**Contact:** Natural Hazards Program Manager, DLCD
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

### Oregon Department of Consumer and Business Services

The Building Codes Division of Oregon's Department of Consumer and Business Services is responsible for administering statewide building codes. Its responsibilities include adoption of statewide construction standards that help create disaster-resistant buildings, particularly for flood, wildfire, wind, foundation stability, and seismic hazards.

Information about wildfire-related building codes is found through this department.

**Contact:** Building Codes Division
**Address:** 1535 Edgewater St. NW, P.O. Box 14470, Salem, OR 97309
**Phone:** (503) 373-4133
**Fax:** (503) 378-2322
**Website:** http://www.cbs.state.or.us/external/bcd

### Oregon Department of Forestry (ODF)

ODF's Fire Prevention Unit is involved in interface wildfire mitigation and provides information about Oregon's Wildfire Hazard Zones. The Protection From Fire section of the ODF website includes Oregon-specific fire protection resources. Wildfire condition reports can be accessed on the website as well. ODF's Protection from Fire Program works to do the following:

- Clarify roles of ODF, landowners, and other agencies in relation to wildland fire protection in Oregon;
- Strengthen the role of forest landowners and the forest industry in the protection system;
- Understand and respond to needs for improving forest health conditions and the role/use of prescribed fire in relation to mixed ownerships, forest fuels and insects and disease; and
- Understand and respond to needs for improving the wildland/urban interface situation.

**Contact:** Oregon Department of Forestry, Fire Prevention Unit
**Address:** 2600 State Street, Salem, Oregon 97310
**Phone:** (503) 945-7440
**Website:** http://www.odf.state.or.us/fireprot.htm

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing, and providing for the prevention, mitigation, and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the state of Oregon.

**Contact:** Office of Emergency Management
**Address:** 595 Cottage Street NE, Salem, OR 97310
**Phone:** (503) 378-2911
**Fax:** (503) 588-1378
**Website:** http://www.osp.state.or.us/oem/

### Office of the State Fire Marshal (OSFM)

The Prevention Unit of Oregon's Office of the State Fire Marshal contains 19 Deputy State Fire Marshals located in various regions. The responsibilities of these deputies include public education for local fire districts and inspection of businesses, public assemblies, schools, daycare centers, and adult foster homes. The State Fire Marshal's

Community Education Services unit works to keep Oregonians safe from fires and injury by providing them with the knowledge to protect themselves and their property.

**Contact:** Oregon State Fire Marshal
**Address:** 4760 Portland Road NE, Salem, Oregon 97305-1760
**Phone:** (503) 378-3473
**Fax:** (503) 373-1825
**Website:** http://159.121.82.250/ Oregon Laws on Fire Protection: http://159.121.82.250/SFM_Admin/firelaws.htm
**Email:** Oregon.sfm@state.or.us

## Federal Resources and Programs

### Federal Emergency Management Agency (FEMA)

FEMA's mission is "to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

**Contact:** FEMA, Federal Regional Center, Region 10
**Address:** 130-228th St. SW, Bothell, WA 98021-9796
**Phone:** (425) 487-4678
**Website:** http://www.fema.gov/Reg-X/index.htm

### Federal Wildland Fire Policy, Wildland/Urban Interface Protection

This is a report describing federal policy and interface fire. Areas of needed improvement are identified and addressed through recommended goals and actions.

**Website:** http://www.fs.fed.us/land/wdfire7c.thm

### National Fire Protection Association (NFPA)

This is the principal federal agency involved in the National Wildland/Urban Interface Fire Protection Initiative. NFPA has information on the Initiative's programs and documents. Other members of the initiative include: the National Association of State Foresters, the US Department of Agriculture Forest Service, the US Department of the Interior, and the United States Fire Administration.

**Contact**: Public Fire Protection Division
**Address**: 1 Battery March Park, P.O. Box 9101, Quincy, MA 02269-9101
**Phone**: (617) 770-3000

### National Interagency Fire Center (NIFC)

The NIFC in Boise, Idaho is the nation's support center for wildland firefighting. Seven federal agencies work together to coordinate and support wildland fire and disaster operations. These agencies include the Bureau of Indian Affairs, Bureau of Land Management, Forest Service, Fish and Wildlife Service, National Park Service, National Weather Service, and Office of Aircraft Services.

**Contact:** National Interagency Fire Center
**Address:** 3833 S. Development Avenue, Boise, Idaho 83705-5354
**Phone:** (208) 387-5512
**Website:** http://www.nifc.gov/

### United States Fire Administration (USFA) of the Federal Emergency Management Agency (FEMA)

As an entity of the Federal Emergency Management Agency, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies through leadership, advocacy, coordination, and support.

**Contact:** USFA, Planning Branch, Mitigation Directorate
**Address:** 16825 S. Seton Ave., Emmitsburg, MD 21727
**Phone:** (301) 447-1000
**Website:** http://www.fema.gov/mit/wfmit.htm - Wildfire Mitigation Planning
http://www.usfa.fema.gov/index.htm - USFA Homepage
http://www.usfa.fema.gov/wildfire/- USFA Resources on Wildfire

### United States Forest Service (USFS)

The USFS is a federal land management organization established to manage the nation's federally owned forests. As part of the Department of Agriculture, it provides timber for people, forage for cattle and wildlife, habitat for fish, plants, and animals, and recreation lands throughout the country.

The USFS offers a possible link from local jurisdictions to federal grant programs.

**Contact:** USDA Forest Service - Pacific Northwest Region
**Address:** 333 SW First Avenue, Portland, Oregon 97204-3440;
P.O. Box 3623, Portland, OR 97208-3623
**Phone:** 503-808-2468
**Webstite:** http://www.fs.fed.us/r6/welcome.htm

## Additional Resources

### American Red Cross

The American Red Cross is a humanitarian organization, led by volunteers, that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area, including disaster planning, preparedness, and education.

**Contact:** American Red Cross, Oregon Trail Chapter
**Address:** P.O. Box 3200, Portland, OR 97208-3200
**Phone:** (503) 284-1234
**Fax:** (503) 284-4247
**Email**: info@redcross-pdx.org

**Website:** http://www.redcross-pdx.org
http://www.redcross.org/services/disaster/keepsafe/volcano.html

### Institute for Business & Home Safety (IBHS)

IBHS was created as an initiative of the insurance industry to reduce damage and losses caused by natural disasters. This website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

**Contact**: Institute for Business and Home Safety
**Address**: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
**Phone**: (813) 286-3400
**Fax**: (813) 286-9960
**E-mail**: info@ibhs.org
**Website**: http://www.ibhs.org/ibhs2

### FireFree Program to Promote Home Safety

In a pioneering effort to address wildfire danger in Bend, Oregon, four local agencies and a Fortune 500 corporation joined together to create "FireFree! Get In The Zone," a public education campaign designed to increase resident participation in wildfire safety and mitigate losses. Spearheaded by SAFECO Corporation, the partnership includes the Bend Fire Department, Deschutes County Rural Fire Protection District #2, Bend City Planning, and The Deschutes National Forest. The Oregon Department of Forestry and a number of local government agencies and businesses have joined the program.

**Contact**: FireFree
**Address**: 63377 Jamison St., Bend, OR 97701
**Phone**: (541) 318-0459
**E-mail**: dcrfpd2@dcrfpd2.com
**Website**: http://www.firefree.org

### Firewise – The National Wildland/Urban Interface Fire program

Firewise maintains a Website designed for people who live in wildfire-prone areas, but it also can be of use to local planners and decision makers. The site offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences.

**Contact**: Firewise
**Address:** PO Box 9101, Quincy, MA 02269-9101
**Phone:** (617) 984-7056
**E-mail**: firewise@firewise.org
**Website**: http://www.firewise.org/

## Publications

*National Fire Protection Association Standard 299: Protection of Life and Property from Wildfire.* National Wildland/Urban Interface Fire Protection Program, (1991). National Fire Protection Association, Washington, D.C.

This document, developed by the NFPA Forest and Rural Fire Protection Committee, provides criteria for fire agencies, land use planners, architects, developers, and local governments to use in the development of areas that may be threatened by wildfire. To obtain this resource:

**Contact**: National Fire Protection Association Publications
**Phone**: (800) 344-3555
**Website**: http://www.nfpa.org or http://www.firewise.org

*An International Collection of Wildland-Urban Interface Resource Materials* (Information Report NOR-X-344). Hirsch, K., Pinedo, M., & Greenlee, J. (1996). Edmonton, Alberta: Canadian Forest Service.

This is a comprehensive bibliography of interface wildfire materials. Over 2,000 resources are included, grouped under the categories of general and technical reports, newspaper articles, and public education materials. The citation format allows the reader to obtain most items through a library or directly from the publisher. The bibliography is available in hard copy or diskette at no cost. It is also available in downloadable PDF form. To obtain this resource:

**Contact**: Canadian Forest Service, Northern Forestry Centre, I-Zone Series
**Phone**: (780) 435-7210
**Website**: http://www.prefire.ucfpl.ucop.edu/uwibib.htm

*Wildland/Urban Interface Fire Hazard Assessment Methodology.* National Wildland/Urban Interface Fire Protection Program, (1998), NFPA, Washington, D.C. To obtain this resource:

**Contact**: Firewise (NFPA Public Fire Protection Division)
**Phone**: (617) 984-7486
**Website**: http://www.firewise.org

*Fire Protection in the Wildland/Urban Interface: Everyone's Responsibility.* National Wildland/Urban Interface Fire Protection Program. (1998). Washington, D.C.: Author. To obtain this resource:

**Contact**: Firewise (NFPA Public Fire Protection Division)
**Phone**: (617) 984-7486
**Website**: http://www.firewise.org

*Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local staffs and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can also write, call, or fax to obtain this document:

**Contact:** Natural Hazards Program Manager
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

*Burning Questions. A Social Science Research Plan for Federal Wildland Fire Management, Machlis, G., Kaplan, A., Tuler, S., Bagby, K., and McKendry, J. (2002)* National Wildfire Coordinating Group.

The plan covers a wide range of topics and questions related to the human dimensions of federal ewildland fire management. Both the beneficial and harmful affects of wildland fire are considered. The plan includes research in the social sciences or anthropology, economics, geography, psychology, political science, and sociology, as well as interdisciplinary fields of research. The plan is national in scale but recognizes the importance of regional variation in wildland fire issues.

**Contact:** Cooperative Park Studies Unit
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (208) 885-7054
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

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## Wildfire Endnotes


[1] Colorado State Forest Service, (July 2001), http://205.169.13.227/depts/emmgmt/wildfireproblem.htm.

[2] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* (July 2000), Department of Land Conservation and Development, Ch. 7.

[3] Wilkinson, Todd. “Prometheus Unbound,” (May/June 2001), Nature Conservancy.

[4] National Interagency Fire Center, *National Register of Urban Wildland Interface Communities Within the Vicinity of Federal Lands that are at High Risk from Wildfire.* (May 2001) http://www.nifc.gov/fireplan/fedreg.html.

[5] United States Forest Service (April 2003)

http://www.biscuitfire.com/facts.htm

[6] DeBano, Leonard; Neary, Daniel; Ffolliott, Peter, *Fire’s Effects on Ecosystems*, 1998, pg. 21

[7] Ibid 22

[8] Ibid 22

[9] Ibid 49

[10] Ibid. pg. 304

[11] Ibid

[12] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* (July 2000), Department of Land Conservation and Development, Ch. 7.

[13] Any Wildland-Urban Interface Issues Beaverton deals with would fall Into this catergory.

[14] Robert Olson Associates, *Metro Regional Hazard Mitigation Policy and Planning Guide*, (June 1999), Metro.

[15] Introductory language in Senate Bill 360, (July 2001), ODF website, http://www.odf.state.or.us/fireprot/sb360.html.

[16] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* (July 2000), Department of Land Conservation and Development, Ch. 7.

[17] DeBano, Leonard; Neary, Daniel; Ffolliott, Peter, *Fire's Effects on Ecosystems*, 1998, pg. 59.

[18] Ibid

[19] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* (July 2000), Department of Land Conservation and Development, Ch. 7.

[20] Ibid.

[21] Ibid.

[22] The Oregonian, Feb. 25, 2001.

[23] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* (July 2000), Department of Land Conservation and Development, Ch. 7.

[24] Colorado State Forest Service, (July 2001), http://205.169.13.227/depts/emmgmt/wildfireproblem.htm.

[25] Burby, R. (Ed.) *Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities*. Washington D.C., (1998) Joseph Henry Press.

[26] Ibid.

[27] Oregon Department of Forestry, (1999) Oregon Forests Report.

[28] Personal Interview. Jim Wolf, Oregon Department of Forestry, February 28, 2001.

[29] Ibid.

[30] Federal Wildland Fire Policy, (July 2001), http://www.fs.fed.us/land/wdfire7c.htm.

[31] Ibid.

[32] Ibid.

[33] Personal Interview. M.J. Harvey, United States Forest Service, March 1, 2001.

[34] Personal Interview, Bill Fleeger, Regional Ecosystem Applied Learning (REAL) Corps, June 30, 2003.

[35] Ibid.

[36] Personal Interview. M.J. Harvey, United States Forest Service, March 1, 2001.

[37] Ibid.

[38] http://www.firewise.org/communities/ffoverview.pdf/ (Accessed 6/26/03)

[39] City of Beaverton Web Page, http://ci.beaverton.or.us/departments/emergency/, (Accessed 4/30/03) (Entire Paragraph)

[40] City of Beaverton Web Page, http://ci.beaverton.or.us/departments/cdd/, (Accessed 5/2/03) (Entire Paragraph)

# Chapter 11
# Earthquake

# Table of Contents

# Why are Earthquakes a threat to Beaverton?

Social and geological records show that Oregon has a history of seismic events. Recent research suggests that the Cascadia Subduction Zone is capable of producing magnitude 9 earthquakes.

Geologists scrutinizing soil layers in a 12-foot-deep trench have uncovered more evidence that the Portland Hills Fault is able to generate earthquakes. The fault runs in a northwest-southeast direction from about the northern edge of Forest Park, along the foot of Portland's West Hills and under downtown Portland. It crosses beneath the Willamette River between the Marquam and Ross Island bridges, runs under Milwaukie and ends about a mile south of the Clackamas River near Oregon City and Gladstone. Sediment layers in the trench were deformed by an earthquake roughly 10,000 years ago, recent enough for the fault to be labeled "active," the scientists said. They also have found clues that two quakes may have occurred on the hidden fault. Deformation of soil deposits both at the school site and the trench suggest that the ancient earthquake may have measured about a magnitude 6.5. That would be a moderate quake that could cause substantial damage.[1]

The existence of other active faults in the Portland Metro Area and other areas of the state are suspected but not confirmed in many cases. Where known to exist, it is believed that they are capable of generating magnitude 7 earthquakes.

Earthquakes pose a serious threat to many Oregon communities. The state ranks third in the nation for future earthquake damage estimates in the future. Projected losses in the Cascadia region alone could exceed $12 billion, destroy 30,000 buildings, and take 8,000 lives in the event of a magnitude 8.5 Cascadia Subduction Zone earthquake.[2] Local governments, planners, emergency managers, and engineers must consider this threat as they seek to balance development and risk. Identifying locations susceptible to seismic activity generated by local faults or the Cascadia Subduction Zone, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in Beaverton.[3]

## Historical Earthquake Events

Several moderate earthquakes have affected Beaverton in the past century. Little damage has occurred in Beaverton as a result, but the earthquakes have rattled nerves, and served to remind residents that their community is at risk of experiencing damaging earthquakes. Multiple small quakes have been occurring in the Portland metro area over the past couple of years. Though most have been too small to be felt in Beaverton it demonstrates the seismic instability of the region. Recent events of note included a magnitude 3.0 earthquake on July 25, 2003 that occurred 9.19 miles NW of Portland and a magnitude 3.3 earthquake that occurred 3.54 miles SSE of Mt. Hood on July 7, 2003.[4]

### April 24, 2003, 3.9 Magnitude Earthquake

A 3.9 magnitude earthquake occurred in the Portland area on April 24, 2003. This quake was the largest quake to be generated by a fault under the Portland area in over 40 years. The quake was followed by seven aftershocks and smaller-deeper tremors were detected for several weeks after.[5] The quake was centered 15.8 km northwest of Portland and 42.0 km north of Canby.

### February 28, 2001, Nisqually Earthquake- Magnitude 6.8

The most recent earthquake to be felt in Beaverton was the Nisqually earthquake, on February 28, 2001. This earthquake was centered northeast of Olympia, Washington, and measured 6.8 on the Richter scale. In the Puget Sound area, this quake caused 400 injuries, one quake-related death, and about $2 billion dollars in damage.[6] In Beaverton, many employees of various businesses went out into parking lots and streets in reaction to the quake, but no damage was caused by it. According to Karen Eubanks of Tualatin Valley Fire and Rescue, Washington County's 911 system was "jammed for several minutes with callers wanting to know more about the quake."[7] While Oregon experienced little damage from this earthquake, it reminded residents what can happen during major earthquakes.

Ironically, the Portland Metropolitan area was planning an earthquake drill in April of 2001 as part of Earthquake Awareness Month, called "Metroshake."[8] This drill involved all cities in the Portland Metropolitan area, as well as Portland Emergency Management, Multnomah County, the State Office of Emergency Management, and the Tualatin Valley Water District, among others. The drill simulated a 6.0 Magnitude quake centered under Lake Oswego, and was run for the purpose of identifying problems in the emergency procedures and plans among cities and agencies.[9] According to chief controller of the Metroshake exercise Scott Porter, "It's really ironic. The 6.8 magnitude quake (in Seattle) happened at 5 minutes to 11:00 A.M., and our scenario was set for 11:00. It's really kind of scary."[10]

### March 25, 1993, Scotts Mills Earthquake- Magnitude 5.7

In 1993, the Scotts Mills earthquake (also known as the "Spring Break Quake") shook Beaverton. It was a magnitude 5.7 on the Richter scale, and caused extensive damage primarily in the communities of Molalla, Woodburn, Newberg, McMinnville, and Salem. In Beaverton, some cracks that were already in school walls got larger. The quake trapped one man in an elevator because the electric motor shorted during the shaking.[11] In addition, the *Valley Times* reported that only 4% of Oregonians were insured at the time of this earthquake.[12] By comparison, the household survey indicated that 57% of respondents had earthquake insurance in 2003.

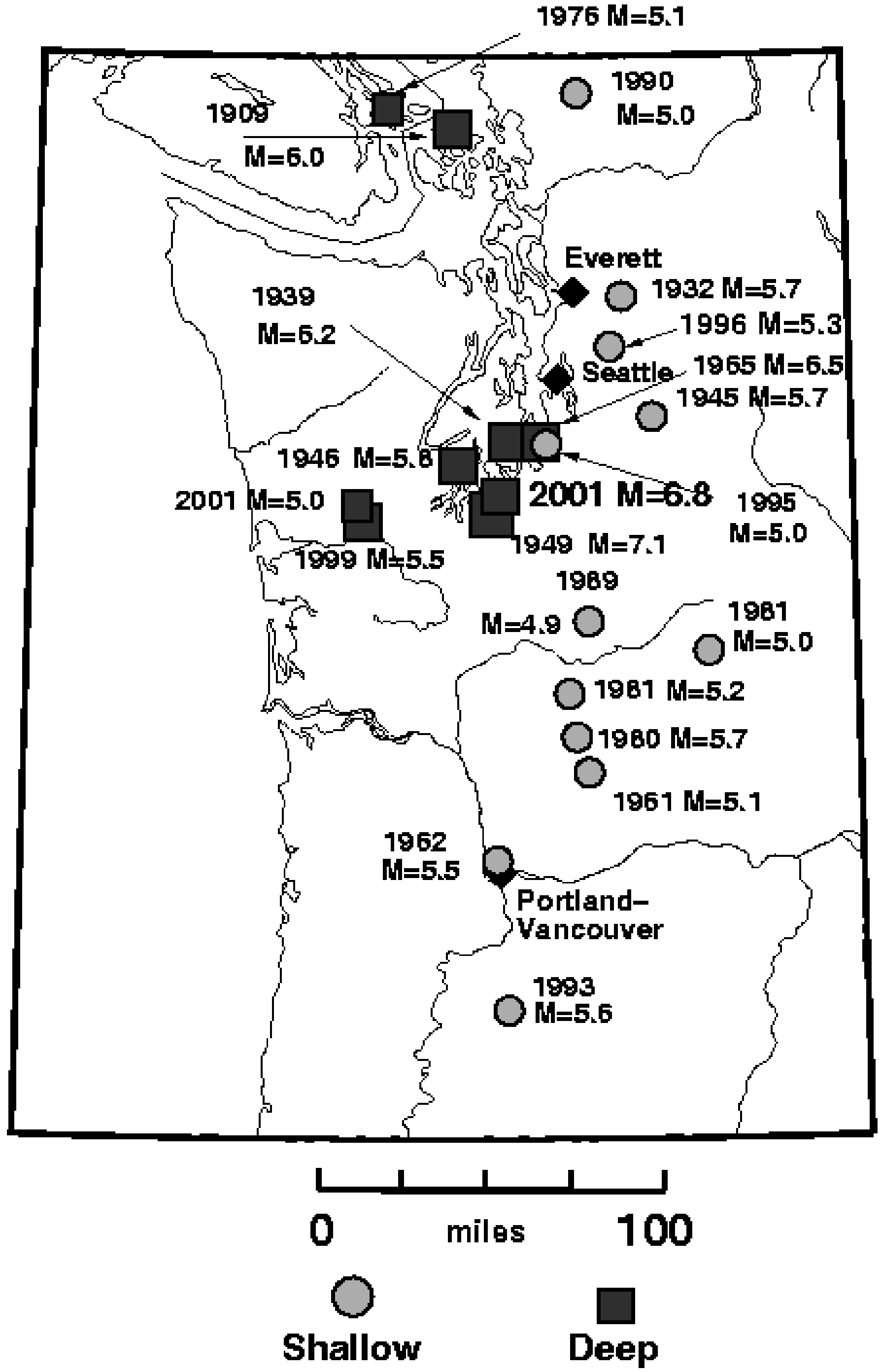
### November 5, 1962, Vancouver, Washington- Magnitude 5.2

Three and a half weeks after the devastating Columbus Day Storm, an earthquake that measured approximately 5.2 on the Richter scale shook the Portland area. It was the largest quake to be generated by a fault under Portland and Vancouver.[13] According to the *Valley Times,* there were no reports of significant damage from the quake in Beaverton. Grocery stores did report rolling of canned goods, but little damage occurred.[14] This earthquake disappeared quickly from headlines, most likely because residents were still recovering from the Columbus Day Storm at the time of the earthquake.[15]

### April 13, 1949, Olympia, Washington- Magnitude 7.1

On April 13, 1949, Beaverton residents felt an earthquake that was centered near Olympia, Washington. In Washington, this quake caused 8 deaths. In Beaverton, the only damages incurred were a few cracked chimneys and fallen plaster.[16] Beaverton High School closed its doors at noon, shortly after the earthquake. According to the school's superintendent, this was not because of the danger, but because the quake left them little concern for their studies.[17]

**Figure 11-1. Selected Pacific Northwest Earthquakes since 1872**




Source: Pacific Northwest Seismograph Network.
www.geophys.washington.edu/SEIS/PNSN/INFO_GENERAL/hist.html

## Causes and Characteristics of Earthquake in Beaverton

Most large earthquakes in the Pacific Northwest are shallow crustal, deep intraplate, or subduction zone earthquakes. These earthquakes can have great impact on Oregon communities. The city of Portland, which lies just east of Beaverton, has at least three crustal faults beneath it. There are several crustal faults near Beaverton that could generate an earthquake of magnitude 6.5 or larger.

### Crustal Fault Earthquakes

Crustal fault earthquakes are the most common of earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.[18] While most crustal fault earthquakes are smaller than magnitude 4.0 and generally create little or no damage, they can produce earthquakes of magnitudes 7.0 and higher and cause extensive damage. The 30-mile long Portland Hills Fault, which runs in a northwest to southeast direction through Portland, was confirmed to be an active fault by DOGAMI in May 2001.[19] This indicates that Portland and its neighbors could face future damages from a magnitude 6.5 or larger earthquake.[20]

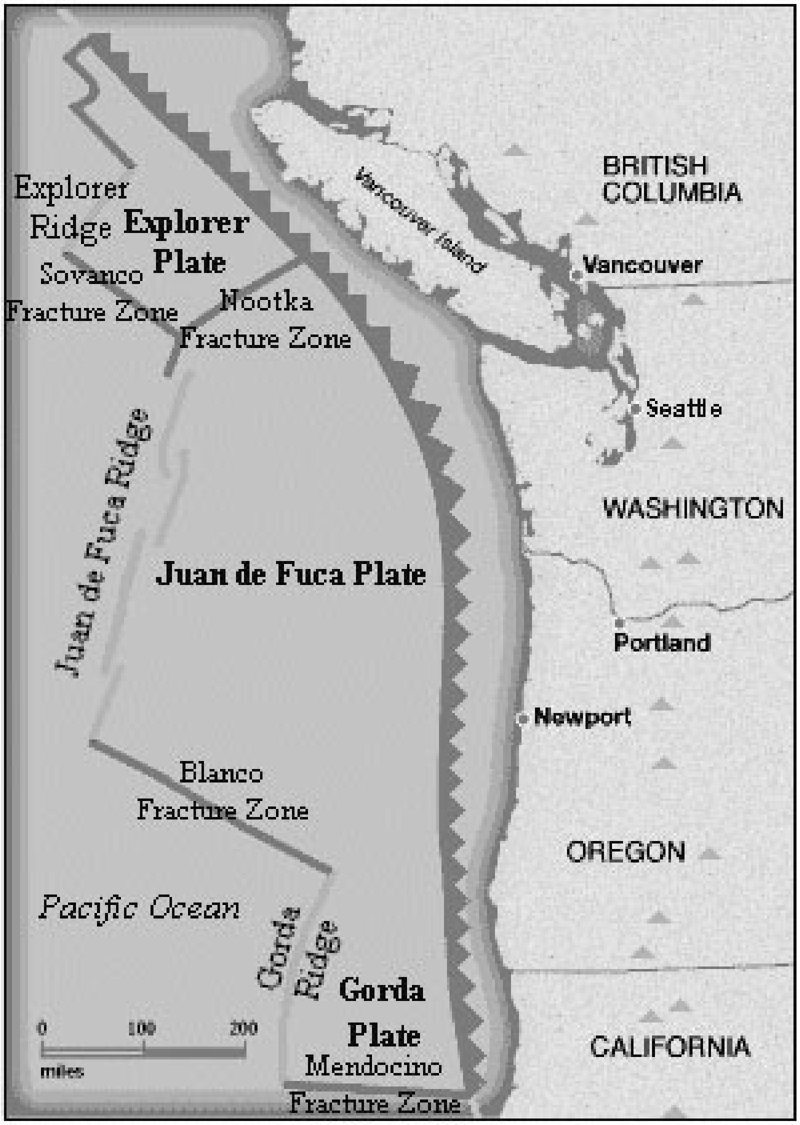
### Deep Interplate Earthquakes

Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach magnitude 7.5.[21] The February 28, 2001 earthquake in Washington State was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah. A 1965 magnitude 6.5-intraplate earthquake centered south of Seattle-Tacoma International Airport caused seven deaths.[22]

### Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1-2 inches per year. This boundary is called the Cascadia Subduction Zone (see Figure 11.2). It extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress. Subduction zones similar to the Cascadia Subduction Zone have produced earthquakes with magnitudes of 8.0 or larger. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5) and the 1964 southern Alaska (magnitude 9.2) earthquakes. Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes, most recently about 300 years ago. It is generally accepted to have been magnitude 9.0 or greater. The average recurrence interval of these great Cascadia earthquakes is approximately 500 years, with gaps between events as small as 200 years and as large as 1000 years. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon including Beaverton. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.[23]

**Figure 11-2. Cascadia Subduction Zone**




Source: Department of Land Conservation and Development.
www.lcd.state.or.us/coast/hazards/juandefucaplates.htm

## Earthquake Related Hazards

### Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

### Earthquake-Related Landslides

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy roads, buildings, utilities, and other critical facilities necessary to respond to and recover from an earthquake. Many communities in Oregon, including Beaverton, are likely to encounter such risks, especially in areas with steep slopes. As the City annexes sloped lands to the northeast and southwest, earthquake-related landslides will begin to pose a bigger threat to homes and infrastructure.

### Liquefaction

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.[24] Areas of susceptibility to liquefaction include areas with ground water tables and sandy soils.[25]

### Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. Amplification depends on the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.[26] Amplification can also occur in areas with deep sediment filled basins. The Tualatin Valley is a good example. The thick sediments and the bowl shape of the basin combine to amplify ground shaking.[27]

## Community Earthquake Issues

Earthquake damage occurs because structures cannot withstand severe shaking. Buildings, airports, schools, and lifelines, including: water and gas lines, transportation systems, electricity, and communication networks suffer damage in earthquakes and can cause death or injury to humans.

The welfare of homes, businesses, and public infrastructure is very important. Addressing the integrity of buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges that Beaverton faces.

### Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people, putting lives at risk and creating great costs to clean up the damages. Changes in the seismic zone rating for the Willamette Valley, in 1990 and 1993, lead to corresponding increases in the construction standards for buildings being built in Beaverton and the rest of the Willamette Valley. In 1993, the seismic zone for the Willamette Valley was upgraded from 2B to 3, requiring stricter construction standards. In most Oregon communities, including Beaverton, many buildings were built before 1993 when building codes were not as strict. Upgrading existing buildings to resist earthquake forces is more expensive than meeting code requirements for new construction. Current building codes only require seismic upgrades when there is significant structural alternation to the building or where there is a change in use that puts building occupants and the community at a greater risk. Therefore, the number of buildings at risk remains high. The lack of funding for such activity is a major issue. Some of the buildings in the old downtown area of Beaverton are more susceptible to earthquake damage because they are made of unreinforced brick and concrete. Although coordination among county and city building code officials is in progress, much work remains to be done to identify and plan for the risks to older structures.

## Infrastructure and Communication

Residents in Beaverton commute frequently by automobile and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community – it disconnects people from work, school, food, and leisure, and separates businesses from their employees, customers, and suppliers.

### Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link – with even minor damages making some areas inaccessible. Because bridges vary in size, materials, siting, and design, any given earthquake will affect them differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made. Much of the interstate highway system was built in the mid to late 1960's.

### Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. All lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

### Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

### Businesses

Seismic activity can cause great loss to businesses – both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to small shop owners who may have difficulty recovering from their losses. According to the business survey conducted as part of this plan, most businesses could remain closed for only two days before suffering serious economic hardship.

### Individual Preparedness

A 1999 DOGAMI survey shows that about 39% of respondents think an earthquake will occur in Oregon within the next 10 years. Only 28% of Oregon residents say they are prepared for an earthquake, and 22% have earthquake insurance. In addition, only 24% correctly identified what to do during an earthquake.[28] According to the household survey conducted in conjunction with the development of this plan, earthquake was one of the respondents' top concerns. Also, as reported earlier, around 56.6% of respondents have insurance for earthquakes.

Because the potential for earthquake occurrences and earthquake-related property damage is relatively high, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property as well as being insured for earthquake, are just a few steps individuals can take to prepare for an earthquake.

### Death and Injury

Death and injury can occur both inside and outside of buildings due to falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life. Deaths can be prevented with proper building design and individual preparedness.

### Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer structural or lifeline damage, quick response to suppress fires is less likely. Therefore, it is necessary for fire stations and critical facilities to be well protected from natural disasters.

> For more information on debris management strategies, refer to FEMA's Public Assistance Debris Management Guide. *(See resources on page 11-31)*

### Debris

Following damage to structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

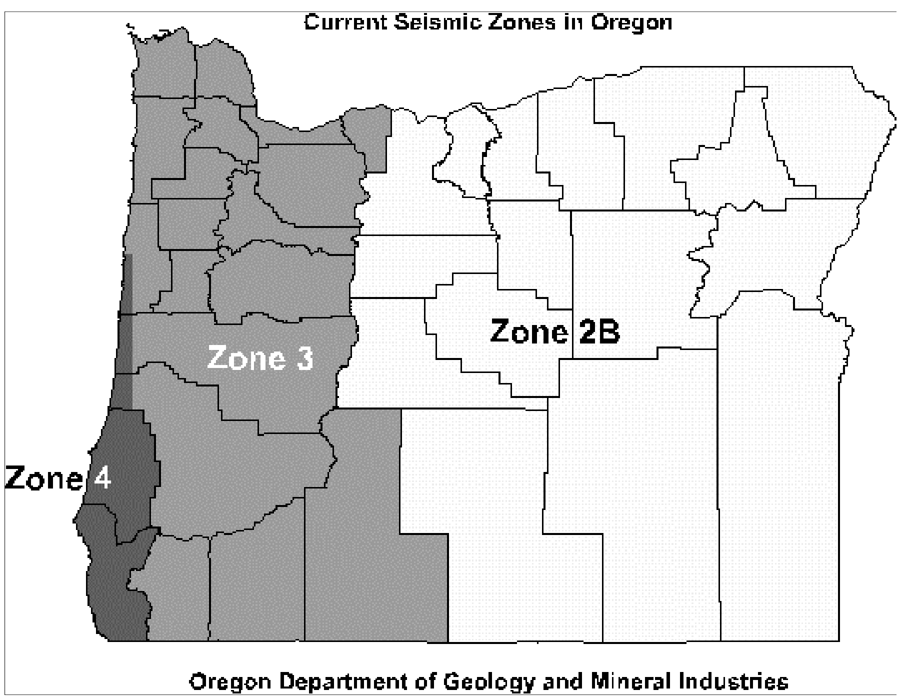
# Earthquake Hazard Assessment

## Hazard Identification

The Department of Geology and Mineral Industries (DOGAMI), in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards and risks, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in Oregon through DOGAMI.[29]

The Oregon Building Codes Division revised and upgraded its construction standards for new buildings to make them resistant to seismic events. The change in State Building Codes reflects updated seismic zones (see Figure 11.3). An increase in zone number reflects increased risk of seismic activity. Many buildings in Beaverton were built prior to the imposition of the new seismic zone code requirements, established in 1993.

### Figure 11-3. Seismic Zones in Oregon



## Vulnerability Assessment

The effects of earthquakes span a large area, and an earthquake occurring in the city would probably be felt throughout the county. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges, many high tech and hazardous material facilities, extensive sewer, water, and natural gas pipelines, a petroleum pipeline, and other critical facilities and private property located in the city. The areas that are particularly vulnerable to potential earthquakes in the city have been identified as those areas near the crustal fault lines.

The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

## Risk Analysis

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experience in a geographic area over a period of time. Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the city due to an earthquake event in a specific location. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available. DOGAMI is leading state initiative in producing relative earthquake maps and conducting risk analyses of various regions in the state.

Table 11-1 presents preliminary damage figures for Washington County for both an 8.5 Cascadia subduction zone event and a 500-year event. This data is not currently available on the city-level. It should be noted that the figures have a high degree of uncertainty and should be used only for general planning purposes.[30]

**Table 11-1. Estimated Earthquake Damage Summary for Washington County**

| Washington County | 8.5 Cascadia Subduction Zone event | 500-year model |
|---|---|---|
| Injuries | 555 | 2,910 |
| Deaths | 10 | 62 |
| Displaced Households | 2,062 | 7,666 |
| Short term shelter needs | 1,284 | 4,660 |
| Economic losses for buildings | $931 million | $3.8 million |
| *Operational the day after the quake:* | | |
| Fire Stations | 66% | NA |
| Police Stations | 64% | NA |
| Schools | 64% | NA |
| Bridges | 79% | NA |
| *Economic losses to:* | | |
| Highways | $15 million | $61 million |
| Airports | $5 million | $23 million |
| *Communication Systems:* | | |
| Economic losses | $752,000 | $4 million |
| Operating the day of the quake | 60% | NA |
| Debris generated (Thousands of ton: | 763 | 2,817 |

Source: Wang, Y., and J.L. Clark, "Earthquake damage in Oregon: Preliminary estimates of future earthquake losses", Special Paper 29, DOGAMI, 1999, p 57.

# Existing Mitigation Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. The goals for the City of Beaverton Natural Hazards Mitigation Action Plan are broad based to include all of the identified hazards addressed in the plan. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Hazard Communication and Coordination through Partnerships
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

## Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations.

### City Programs

#### Building Codes

The City's Building Division is responsible for enforcing the State of Oregon Building Codes, which incorporate seismic considerations. These "Codes" are the laws that regulate how a building is to be constructed, ranging from how strong the walls must be, to how much insulation must be in them.

#### Local Seismic Upgrades

The City of Beaverton is currently undergoing seismic upgrades to the City's water system including the water facilities and reservoirs. [31] [32] The City also complete structural and non-structural seismic upgrades to its Operations Department facilities.

#### Quakex

City personnel participated in Quakex 2003 in April. This statewide drill simulated the occurrence of a magnitude 9.0 subduction zone earthquake off the coast of Oregon. The exercise was broken into two components: the response phase, which took place from April 2 though April 3, and the recovery phase, which took place between April 8 and April 9. The purpose of the drill was to train agencies throughout the state in how to cooperate and communicate during a large earthquake, and to identify short and long term efforts needed to respond to a large-scale disaster.[33]

### State Programs

#### State Building Codes[34]

The Oregon State Building Codes Division adopts statewide standards for building construction that are administered by the state, cities and counties throughout Oregon. The codes apply to new construction and to the alteration of, or addition to, existing structures. The One and Two Family Dwelling Code and the Structural Specialty Code (both included in the State Building Code) contain maps identifying the various seismic zones for Oregon, as described in Section 2 of this guide. The Structural Specialty Code is based on the 1997 edition of the Uniform Building Code published by the International Conference of Building Officials and amended by the state of Oregon. The Uniform Building Code contains specific regulations for development within seismic zones.[35]

Within these standards are six levels of design and engineering specifications that are applied to areas according to the expected degree of ground motion and site conditions that a given area could experience during an earthquake (ORS 455.447). The Structural Code requires a site-specific seismic hazard report for projects including essential facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures, such as large schools and prisons.

The seismic hazard report required by the Structural Code for essential facilities and special occupancy structures must take into consideration factors such as the seismic zone, soil characteristics including amplification and liquefaction potential, any known faults, and potential landslides. The findings of the seismic hazard report must be considered in the design of the building. The Dwelling Code simply incorporates prescriptive requirements for foundation reinforcement and framing connections based on the applicable seismic zone for the area. The cost of these requirements is rarely more than a small percentage of the overall cost for a new building.[36]

The requirements for existing buildings vary depending on the type and size of the alteration and whether there is a change in the use of the building to house a more hazardous use. Oregon State Building Codes recognize the difficulty of meeting new construction standards in existing buildings and allow some exception to the general seismic standards. Upgrading existing buildings to resist earthquake forces is more expensive than meeting code requirements for new construction. State code only requires seismic upgrades when there is significant structural alteration to the building or where there is a change in use that puts building occupants and the community at a greater risk. The local building official is responsible for enforcing these codes.[17] Although there is no statewide building code for substandard structures, local communities have the option of adopting one to mitigate hazards in existing buildings. The state has adopted regulations to abate buildings damaged by an earthquake in Oregon Administrative Rules (OAR) 918-470. Oregon Revised Statutes (ORS) 455.020 and 455.390-400 also allow municipalities to create local programs to require seismic retrofitting of existing buildings within their communities. The building codes do not regulate public utilities and facilities constructed in public right-of-ways, such as bridges that are regulated by the Department of Transportation.

### Senate Bill 13: Seismic Event Preparation

Senate Bill 13, signed by Governor John Kitzhaber on June 14, 2001, requires each state and local agency and persons employing 250 or more full-time employees to develop seismic preparation procedures and inform their employees about the procedures. Further, the bill requires agencies to conduct drills in accordance with Office of Emergency Management guidelines. These drills must include "familiarization with routes and methods of exiting the building and methods of duck, cover and hold during an earthquake."

### Senate Bill 14: Seismic Surveys For School Buildings

The Governor signed Senate Bill 14 on July 19, 2001. It requires the State Board of Higher Education to provide for seismic safety surveys of buildings that have a capacity of 250 or more persons and are routinely used for student activities by public institutions or departments under the control of the board. A seismic safety survey is not required for any building that has previously undergone a seismic safety survey or that has been constructed to the state building code standards in effect for the seismic zone classification. Subject to available funding, if a building is found to pose an undue risk to life and safety during a seismic event, a plan shall be developed for seismic rehabilitation or other seismic risk reducing activities. All seismic rehabilitation or other actions to reduce seismic risk must be completed before January 1, 2032, subject to available funding.

#### Senate Bill 15: Seismic Surveys For Hospital Buildings

Governor John Kitzhaber signed Senate Bill 15 on July 19, 2001. It requires the Health Division to provide for seismic safety surveys of hospital buildings that contain an acute inpatient care facility. Seismic surveys shall also be conducted on fire stations, police stations, sheriffs' offices, and similar facilities subject to available funding. The surveys should be completed by January 1, 2007. A seismic survey is not required for any building that has undergone a survey or that has been constructed to the state building code standards in effect for the seismic zone classification at the site. Subject to available funding, if a building is evaluated and found to pose an undue risk to life and safety during a seismic event, the acute inpatient care facility, fire department, fire district or law enforcement agency using the building shall develop a plan for seismic rehabilitation of the building or for other actions to reduce the risk. All seismic rehabilitations or other actions to reduce the risk must be completed before January 1, 2022, subject to available funding.

#### Earthquake Awareness Month

April is Earthquake Awareness Month. During the month, the State Office of Emergency Management encourages individuals to strap down computers, heavy furniture, and bookshelves. In addition, Oregon Natural Hazards Workgroup distributed a flyer with educational information about how to prepare for an earthquake.

#### Earthquake Education

Earthquake education in schools is ongoing in Oregon. Schools conduct periodic earthquake drills and educate students how to respond when an earthquake event occurs. For example, St. Cecelia, a local private school, performs earthquake drills along with fire drills.[37]

### Federal Programs

#### National Earthquake Hazards Reduction Program (NEHRP)

NEHRP's mission includes improved understanding, characterization and prediction of hazards and vulnerabilities; improved model building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The Act designates FEMA as the lead agency of the program, and assigns several planning, coordinating and reporting responsibilities.

### National Earthquake Loss Reduction Program (NEP)

NEP was formed as a result of the report "Strategy for National Earthquake Loss Reduction" prepared by the Office of Science and Technology Policy (OSTP) in April 1996. The NEP "aims to focus scarce research and development dollars on the most effective means for saving lives and property and limiting the social disruptions from earthquakes, coordinate federal earthquake mitigation research and development and emergency planning in a number of agencies beyond those in NEHRP to avoid duplication and ensure focus on priority goals, and cooperate with the private sector and with state and local jurisdictions to apply effective mitigation strategies and measures." The NEP does not replace NEHRP, but encompasses a wider range of earthquake hazard reduction activities than those supported by the NEHRP agencies, and provides a framework within which these activities can be more effectively coordinated.

### The National Earthquake Technical Assistance Program (NETAP)

The NETAP is a technical assistance program created to provide ad hoc short-term architectural and engineering support to state/local communities as they are related to earthquake mitigation. The program was designed to enhance the state/local communities' ability to become more resistant to seismic hazards. This assistance cannot be used for actions that are covered under the State's/Territories Performance Partnership Agreement (PPA). This program assists in carrying out the statutory authorities of the National Earthquake Hazards Reduction Act of 1977, as amended.

Technical assistance under the NETAP is available for use by the state/local communities within the 45 eligible and or participating seismic states and U.S. territories. This assistance is provided at no cost to the requesting local community/state government.

Examples of NETAP projects are seismic retrofit/evaluation training, evaluation of seismic hazards critical/essential facilities, post earthquake evaluations of buildings and development of retrofit guidance for homeowners.

### National Seismic Hazard Mapping Project

National maps of the earthquake shaking hazard in the United States have been produced since 1948. Scientists revise these maps as new earthquake studies improve their understanding of this hazard. After thorough review, professional organizations of engineers in turn update the seismic-risk maps and seismic design provisions contained in building codes. More than 20,000 cities, counties, and local government agencies use building codes, such as the Uniform Building Code, to help establish the construction requirements necessary to preserve public health and safety in earthquakes. The 1996 U.S. Geological Survey shaking-hazard maps for the United States are based on current information about the rate at which earthquakes occur in different areas and on how far strong shaking extends from quake sources.

# Earthquake Mitigation Action Items

The earthquake mitigation action items provide direction on specific activities that the City, organizations and residents can undertake to reduce risk and prevent loss from earthquake events. There are four short-term action items and five long-term earthquake action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

**ST-EQ#1: Identify funding sources for implementing earthquake mitigation in Beaverton**

***Ideas for Implementation***

- Coordinate with Washington County to leverage funds for earthquake loss reduction program similar to the City of Seattle's Project Impact model; and
- Evaluate grant and foundations that support earthquake mitigation activities.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Engineering Department, Economic Development – Mayor's Office Program, Community Development Department, Emergency Management
**External Partners:** Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM), Partners for Loss Prevention, Washington County
**Timeline:** 1-2 years
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Improve Partnerships for Communication and Coordination, Ensure Implementation of Mitigation Activities

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**ST-EQ#2: Reduce non-structural hazards in homes, schools, businesses, and government offices.**

***Ideas for Implementation***

- Provide training to government and school facility managers and teachers on securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits;

- Encourage facility managers, business owners, and teachers to refer to FEMA's practical guidebook: Reducing the Risks of Nonstructural Earthquake Damage;
- Conduct periodic safety inspections of nonstructural seismic hazards;
- Encourage homeowners to use Is Your Home Protected from Earthquake Disaster? A Homeowner's Guide to Earthquake Retrofit (IBHS) for economic and efficient mitigation techniques; and
- Organize retrofitting classes for homeowners, building professionals, and contractors.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development Department
**External Partners:** Washington County, Federal Emergency Management Agency, Oregon Emergency Management, School District
**Timeline:** 1-2 years
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards, Ensure Implementation of Mitigation Activities

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**ST-EQ#3: Pursue structural mitigation of critical facilities, infrastructure, public buildings, and schools for the earthquake threat.**

***Ideas for Implementation***

- Coordinate with Washington County to identify and retrofit critical facilities, to stricter seismic standards; and
- Encourage the state legislature to adopt retrofitting incentives.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development Department, Engineering Department, Operations & Maintenance Department
**External Partners:** School Districts, Special Districts, Hospitals, Washington County, Oregon Department of Transportation (ODOT)
**Timeline:** Ongoing
**Plan Goals Addressed:** Enhance Emergency Services

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**ST- EQ#4: Improve technical data and analysis of earthquake hazards.**

***Ideas for Implementation***

- Develop and update an inventory of at- risk structures in Beaverton;
- Update Beaverton earthquake HAZUS data to improve accuracy of the vulnerability assessment for Beaverton;

- Encourage local government officials to use Metro's earthquake hazards reports and earthquake maps to develop additional maps land use documents; and
- Conduct risk analysis incorporating HAZUS data and earthquake maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities and regulating land use.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Community Development Department, ISD/GIS
**External Partners:** Portland State University, Washington County, Metro, Oregon State University
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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**LT-EQ#1: Establish a program aimed at helping private property owners and businesses perform structural retrofitting.**

***Ideas for Implementation***

- Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.); and
- Lobby state legislature to allow for adopting incentives that authorizes property tax incentives or deferrals to offset the costs of voluntary rehabilitation for existing buildings.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development – Mayor's Office, Neighborhood Program – Mayor's Office
**External Partners:** Washington County Assessment and Taxation, State Finance, Federal Emergency Management Agency (FEMA), Beaverton Area Chamber of Commerce, Westside Economic Alliance
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Improve Partnerships Communication and Coordination, Ensure Implementation of Mitigation Activities

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**LT-EQ#2: Encourage purchase of earthquake hazard insurance by forming partnerships with the insurance and real estate industries.**

***Ideas for Implementation***

- Make contacts with insurance industry representatives to keep up to date about their requirements, rates, and plans;
- Provide earthquake insurance information to customers; and
- Work with Real Estate Industry representatives to educate them about what types of structures are resistant to earthquakes.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development – Mayor's Office
Neighborhood Program – Mayor's Office
**External Partners:** Washington County, Insurance Information Service of Oregon and Idaho (IISOI)
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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**LT-EQ#3: Develop public/private partnerships to pursue efficient methods to retrofit structures.**

*Ideas for Implementation*

- Develop incentives (tax incentives or public recognition) for private contractors and architects to work on retrofitting public buildings and other infrastructure. This may help to minimize the funding shortage issue that has caused a number of high risk sites to remain without retrofitting; and
- Educate building contractors and architects on seismic design principles.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development – Mayor's Office Program, Emergency Management, Community Development Department
**External Partners:** Home Builders Association, American Planning Association, American Institute of Architects, Westside Economic Alliance, Chamber of Commerce, Downtown Business Association, and renters groups
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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**LT-EQ#4: Improve local capabilities to perform earthquake building safety evaluations.**

*Ideas for Implementation*

- Offer training in procedures for earthquake building safety evaluations to CERT volunteers through Beaverton's new Community Emergency Response Team Program; and
- Offer periodic training in ATC-20 and ATC-21 procedures for earthquake building safety evaluations and encourage local building officials and other public and private officials (facilities, maintenance, engineering, architecture) to attend.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Emergency Management, Finance/ISD/GIS

**Partner Organizations:** Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM)
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

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**LT-EQ#5: Assure that all Beaverton residents, regardless of income, disability, or ethnic group, receive information about earthquakes and have the opportunity to mitigate earthquake hazards in their home.**

***Ideas for Implementation***

- Enforce seismic building codes; and
- Develop educational materials in appropriate languages including: Spanish, Vietnamese, Laotian, and Korean.

**Coordinating Organization:** City of Beaverton
**Internal Partners:** Economic Development – Mayor's Office Program, Neighborhood Program – Mayor's Office
**External Partners:** Committee for Citizen Involvement (CCI), School Districts
**Timeline:** Ongoing
**Plan Goal Addressed:** Improve Partnerships for Communication and Coordination, Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards.

# Earthquake Resource Directory

## City Resources

### Emergency Management Program

The City of Beaverton Emergency Management Program is responsible for preparing for and responding to various types of emergencies within in Beaverton, including natural disasters.

**Contact:** Emergency Manager, Emergency Management
**Address:** 20665 SW Blanton Street in Aloha
**Phone:** (503) 642-0383
**Email:** info@ocem.org
**Website:** http://www.ci.beaverton.or.us/departments/emergency/

### Community Development Department

The Community Development Department is responsible for the administration of the Community Development Code. Responsibilities include overseeing land development and building plan review and inspections. The offices of Building Services, Development Services, and

Planning Services are part of the Community Development Department. The Building Division is responsible for enforcing the State of Oregon Building Codes. These "Codes" are the laws that regulate how a building is to be constructed, ranging from how strong the walls must be, to how much insulation must be in them.

**Contact:** CDD Director
**Address:** 4755 SW Griffith Dr. Beaverton, OR 97005
**Phone:** (503) 526-2493
**Website:** http://www.ci.beaverton.or.us/departments/cdd
**Email:** cddmail@ci.Beaverton.or.us

### Engineering Department

The City of Beaverton Engineering Department provides engineering and construction support to capital improvement projects and modifications to the city's infrastructure.

**Contact:** Engineering Director
**Address:** 4755 SW Griffith Dr. Beaverton, OR 97005
**Phone:** (503) 526-2269
**Website:** http://www.ci.beaverton.or.us/departments/engineering/
**Email**: engmail@ci.Beaverton.or.us

### Operations and Maintenance Department

The City of Beaverton's Operations Department is responsible for maintaining the integrity of the city's infrastructure, including roadways, storm drainage, water quality facilities, and landscapes.

**Contact:** Operations Director
**Address:** 9600 SW Allen Blvd., Beaverton, OR.
**Phone:** (503) 526-2220
**Website:** http://www.ci.Beaverton.or.us/departments
**Email:** opsmail@ci.Beaverton.us.or

### Finance Department

The Information Systems Department (ISD) is part of the Finance Department and includes GIS Services.

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

## County Resources

### Washington County Building Services Division

The Building Services Division issues a variety of permits and enforces building codes. It also works on countywide coordination among building code officials to improve the effectiveness of building inspections during an unscheduled event.

**Contact:** Washington County Building Official
**Address:** 155 N. First Avenue, Suite 350-12, Hillsboro, OR 97124
**Phone**: (503) 846-3470
**Fax**: (503) 846-3993
**Website**: http://www.co.washington.or.us/deptmts/lut/land_dev.htm

### Washington County Department of Land Use and Transportation

The Washington County Land Use and Transportation Department plans, builds, an maintains the County's transportation systems and prepares, implements, an enforces land use plans, policies, and related state and county mandates.

**Contact:** Washington County Land Development Services Division
**Phone:** (503) 846-3470
**Fax:** (503) 846-4412
**Address:** 155 N. First Avenue, Suite 350 Hillsboro, OR 97124
**Website:** http://www.co.washington.or.us/deptmts/lut/lut.htm
**Email:** lutdir@co.washington.or.us

### Office of Consolidated Emergency Management

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff. Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact:** Director, Washington County Emergency Management
**Address:** 20665 SW Blanton St. Aloha, OR, 97007
**Phone:** (503) 642.0371
**Website:** http://www.ocem.org
**Email:** info@ocem.org

## State Resources

### Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to natural hazards, wit flood as its major focus. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance such as conducting workshops, reviewing local land use plan amendments, and working interactively with other agencies.

**Contact:** Natural Hazards Program Manager
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

### Oregon Department of Geology and Mineral Industries (DOGAMI)

The mission of the Department of Geology and Mineral Industries is to serve a broad public by providing a cost-effective source of geologic information for Oregonians and to use that information in partnership to reduce the future loss of life and property due to potentially devastating earthquakes, tsunamis, landslides, floods, and other geologic hazards. The Department has mapped earthquake hazards in most of western Oregon.

**Contacts**: Deputy State Geologist, Seismic, Tsunami, and Coastal Hazards Team Leaders
**Address**: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
**Phone**: (503) 731-4100
**Fax**: (503) 731-4066
**Website**: http://sarvis.dogami.state.or.us/homepage

### Oregon Department of Consumer & Business Services-Building Codes Division

The Building Codes Division (BCD) sets statewide standards for design, construction, and alteration of buildings that include resistance to seismic forces. BCD is active on several earthquake committees and funds construction related continuing education programs. BCD registers persons qualified to inspect buildings as safe or unsafe to occupy following an earthquake and works with OEM to assign inspection teams where they are needed.

**Contact**: Building Codes Division
**Address**: 1535 Edgewater St. NW, P.O. Box 14470, Salem, Oregon 97309
**Phone**: (503) 378-4133
**Fax**: (503) 378-2322
**Website**: http://www.cbs.state.or.us/external

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing, and providing for the prevention, mitigation and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the state of Oregon. OEM coordinates disaster support to local governments and works with BCD to deploy additional building inspectors when needed for damage assessment.

**Contact:** Earthquake and Tsunami Program Coordinator
**Address:** 595 Cottage St. NE, Salem, Oregon 97301
**Phone:** (503) 378-2911
**Fax:** (503) 588-1378
**Website:** http://www.osp.state.or.us/oem/

### The Nature of the Northwest Information Center

The Nature of the Northwest Information Center is operated jointly by the Oregon Department of Geology and Mineral Industries and the USDA Forest Service. It offers selections of maps and publications from state, federal, and private agencies. DOGAMI's earthquake hazard maps can be ordered from this site.

**Address**: Suite 177, 800 NE Oregon Street # 5, Portland, Oregon 97232
**Phone**: (503) 872-2750
**Fax**: (503) 731-4066
**Email**: Nature.of.NW@state.or.us
**Website**: http://www.naturenw.org/geo-earthquakes.htm

## Federal Resources

### Federal Emergency Management Agency (FEMA)

FEMA is heavily involved with seismic risks in Oregon and has aided in several projects in Portland and Klamath Falls. The Federal Emergency Management Agency (FEMA) is an independent agency of the Federal Government, reporting to the President. FEMA's purpose is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response, and recovery. FEMA coordinates the federal response and provides disaster relief funds following a natural hazard event and works most closely with Oregon Emergency Management (OEM).

**Contact:** Public Affairs Officer, FEMA, Federal Regional Center,
**Address:** 130 228th Street, St., Bothell, WA 98021-9796
**Phone:** (425) 487-4610
**Fax:** (425) 487-4690
**Email:** opa@fema.gov
**Website:** http://www.fema.gov/library/quakef.htm

### US Geological Survey (USGS)

The USGS is an active seismic research organization that also provides funding for research. (For an example of such research, see Recommended Seismic Publications below).

**Contact**: USGS, National Earthquake Information Center
**Address**: Box 25046; DFC, MS 967; Denver, Colorado 80225
**Phone**: (303) 273-8500
**Fax**: (303) 273-8450
**Website**: http://neic.usgs.gov

### Building Seismic Safety Council (BSSC)

The Building Seismic Safety Council (BSSC), established by the National Institute of Building Sciences (NIBS), deals with complex regulatory, technical, social, and economic issues and develops and promotes building earthquake risk mitigation regulatory provisions for the nation.

**Address**: 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005
**Phone**: (202) 289-7800
**Fax**: (202) 289-1092
**Website**: http://www.bssconline.org/

### Western States Seismic Policy Council (WSSPC)

The WSSPC is a regional organization that includes representatives of the earthquake programs of thirteen states (Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon Utah, Washington, and Wyoming), three U.S. territories (American Samoa, Commonwealth of the Northern Mariana Islands and Guam), one Canadian Province (British Columbia), and one Canadian Territory (Yukon). The primary aims of the organization have been: to improve public understanding of seismic risk; to improve earthquake preparedness; and, to provide a cooperative forum to enhance transfer of mitigation technologies at the local, state, interstate, and national levels.

The mission of the Council is to provide a forum to advance earthquake hazard reduction programs throughout the western region and to develop, recommend, and present seismic policies and programs through information exchange, research and education.

**Contact:** WSSPC, Executive Director
**Address**: 121 Second Street, 4th Floor, San Francisco, CA 94105
**Phone**: (415) 974-6435
**Fax**: (415) 974-1747
**Email:** wsspc@wsspc.com
**Website**: http://www.wsspc.org/

### Cascadia Region Earthquake Workgroup (CREW)

CREW provides information on regional earthquake hazards, facts and mitigation strategies for the home and business office. CREW is a coalition of private and public representative s working together to improve the ability of Cascadia Region communities to reduce the effects of earthquake events. Members are from Oregon, Washington, California , and British Columbia. Goals are to:

- Promote efforts to reduce the loss of life and property.
- Conduct education efforts to motivate key decision makers to reduce risks associated with earthquakes.
- Foster productive linkages between scientists, critical infrastructure provides, businesses and governmental agencies in order to improve the viability of communities after an earthquake.

**Contact:** CREW, Executive Director
**Address**: 1330A S. 2nd Street, #105, Mount Vernon, WA 97273
**Phone**: (360) 336-5494
**Fax**: (360) 336-2837
**Website**: http://www.crew.org/

# Additional Resources

## Publications

*Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. You can write, call, fax, or go on-line to obtain this document.

**Contact:** Natural Hazards Program Manager, DLCD
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

*Environmental, Groundwater and Engineering Geology: Applications for Oregon – Earthquake Risks and Mitigation in Oregon*, Yumei Wang, (1998) Oregon Department of Geology and Mineral Industries, Star Publishing.

This paper deals with earthquake risks in Oregon, what is being done today, and what policies and programs are in action to help prevent loss and damage from seismic events. This article also gives a good list of organizations that are doing work in this field within the state. This article is somewhat technical but provides vital information to communities around the state.

**Contact**: DOGAMI
**Address**: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
**Phone**: (503) 731-4100
**Fax**: (503) 731-4066
**Website**: http://sarvis.dogami.state.or.us/homepage

*Special Paper 29: Earthquake damage in Oregon: Preliminary estimates of future earthquake losses*, Yumei Wang, Oregon Department Of Geology And Mineral Industries.

Wang, a geotechnical engineer, analyzed all faults with a 10% chance of causing an earthquake in the next 50 years and projected potential damage. Wang stresses that these are preliminary figures. "There are two things we could not incorporate into this study that would significantly increase these figures. One is a tsunami. The other is an inventory of unreinforced brick or masonry buildings."

**Contact**: DOGAMI
**Address**: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
**Phone**: (503) 731-4100
**Fax**: (503) 731-4066
**Website**: http://sarvis.dogami.state.or.us/homepage

Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners*, Wolfe, Myer R. et. al., (1986) University of Colorado, Institute of Behavioral Science, National Science Foundation.*

This handbook provides techniques that planners and others can utilize to help mitigate for seismic hazards. It provides information on the effects of earthquakes, sources on risk assessment, and effects of earthquakes on the built environment. The handbook also gives examples on application and implementation of planning techniques to be used by local communities.

**Contact**: Natural Hazards Research and Applications Information Center
**Address**: University of Colorado, 482 UCB, Boulder, CO 80309-0482
**Phone**: (303) 492-6818
**Fax:** (303) 492-2151
**Website**: http://www.colorado.edu/UCB/Research/IBS/hazards

*Using Earthquake Hazard Maps: A Guide for Local Governments in the Portland Metropolitan Region; Evaluation of Earthquake Hazard Maps for the Portland Metropolitan Region* Spangle Associates, (1998/1999) Urban Planning and Research, Portola Valley, California.

These two publications are useful for local governments concerned with land use in earthquake hazard areas. The proximity of Washington County to Portland and their interactive communities make these guides applicable to the County. The publications are written in clear and simplistic language and address issues such as how to apply earthquake hazard maps for land use decisions.

**Contact**: DOGAMI
**Address**: 800 NE Oregon St., Suite 965, Portland, Oregon 97232

**Phone**: (503) 731-4100
**Fax**: (503) 731-4066
**Website**: http://sarvis.dogami.state.or.us/homepage

*Public Assistance Debris Management Guide*, Federal Emergency Management Agency (July 2000).

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The *Public Assistance Debris Management Guide* is available in hard copy or on the FEMA website.

**Contact:** FEMA Distribution Center
**Address**: 130 228th Street, SW, Bothell, WA 98021-9796
**Phone:** (800) 480-2520
**Fax**: (425) 487-4622
**Website:** http://www.fema.gov/r-n-r/pa/dmgtoc.htm

## Earthquake Endnotes

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# Chapter 12
# Volcano-Related Events

## Table of Contents

# Why are Volcano-Related Events a threat to Beaverton?

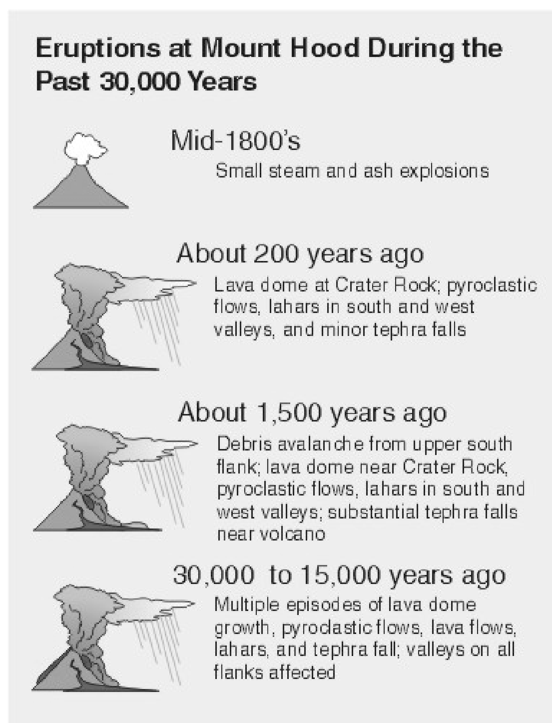
Beaverton and the Pacific Northwest lie on the "Ring of Fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the Ring of Fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs know as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when the hotter molten materials, or magma, rise to the surface.

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, and produce flying debris and ash clouds. The immediate danger area in a Volcano-Related Events generally lies within a 20-mile radius of the blast site. Although there are no active volcanoes in Beaverton or Washington County, there are a number of active volcanoes within the 100-mile danger areas that do pose a threat to city residents and property. The threat they pose is associated primarily with ash fall.

## History of Volcano-Related Events in the Pacific Northwest

There are five major volcanoes in the Cascade region that are in relative proximity and pose a potential threat to Beaverton. They include Mount St. Helens, Mount Hood, Mount Rainier, Mount Adams, and Mount Jefferson. Of the five, all are known or suspected to be active, and most have geological records that indicate past histories of explosive eruptions with large ash releases. Mount Hood is the only volcano that has no geological evidence of large explosive events, though it still poses a threat of ash releases.

**Figure 12-1**




Source: USGS Cascades Volcano Observatory

### Mount Hood

Mount Hood is located about 50 miles southeast of Portland. It has been recurrently active over the past 50,000 years. It has had two significant eruptive periods in geologically recent times, one about 1,500 years ago and another about 200 years ago. Figure 12.1 shows the major geologic events in the Mount Hood Region during the past 30,000 years.

While Mount Hood has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of small explosions generating pyroclastic flows, ash clouds, and lahars (mud and debris flows).

### Mount St. Helens

Mount St. Helens, located in southwestern Washington about fifty miles northeast of Portland, is fifty thousand years old. Over the past 521 years, it has produced four major explosive eruptions and dozens of smaller eruptions. On May 18th, 1980, Mount St. Helens "…exploded violently after two months of intense earthquake activity and intermittent, relatively weak eruptions, causing the worst volcanic disaster in the recorded history of the United States."[1]

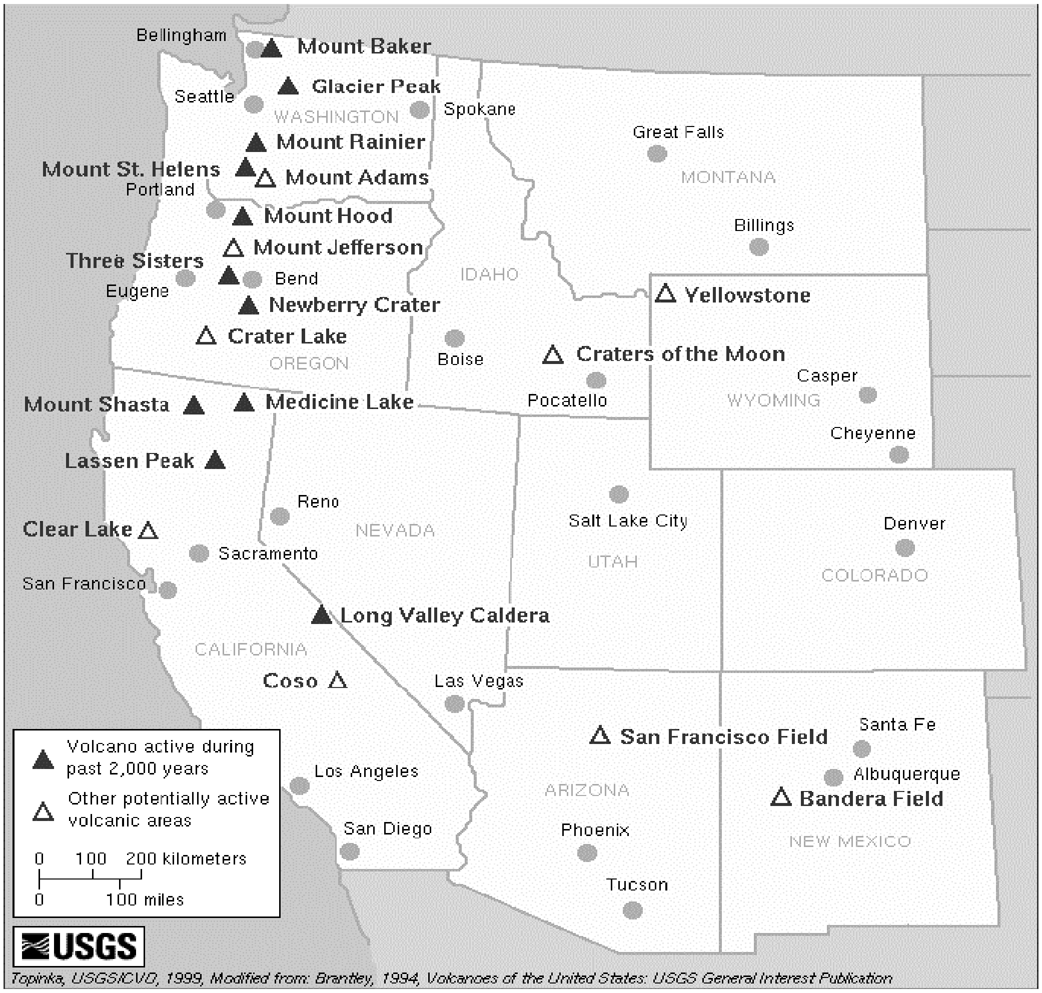
Damage to the built environment within the immediate hazard vicinity in Washington state included twenty-seven bridges, about two hundred homes, more than 185 miles of highways and roads, and fifteen miles of railways. Ash from the eruption column and cloud spread across the United States in three days and circled around the Earth in fifteen days. Detectable amounts of ash were noted in an area covering 22,000 square miles. Debris flows quickly filled the Toutle and Cowlitz Rivers and ultimately flowed into the Columbia River at Longview, Washington. The debris blocked the main shipping channel in the Columbia, stranded ships in port, and closed the ports of Portland, Vancouver, and Kalama for over a month. Several water and sewage treatment facilities were also damaged or destroyed. The estimated damage attributed to the eruption was $1.1 billion.

The May 18, 1980 eruption was preceded by about two months of precursor activity, including dome building, minor earthquakes, and venting of gasses. The lateral blast, debris valance, and mudflow associated with the eruptions caused extensive loss of life and widespread destruction of property. The eruption triggered a magnitude 5.1 earthquake about one mile beneath the volcano. In the six-year period after the initial eruption, hundreds of small ash emissions at Mount St. Helens occurred.

The eruption of Mount St. Helens took the lives of 57 people and nearly 7,000 big game animals. All birds and most small mammals in the area were killed as were twelve million Chinook and Coho salmon fingerlings that perished when their hatcheries were destroyed.

The May 18, 1980 eruption was followed by five smaller explosive eruptions over a period of five months. [2] A series of 16 dome-building eruptions constructed the new, 880-foot high lava dome in the crater formed by the May 18, 1980 eruption. An eruption occurring in 1480 A.D. was approximately five times larger than the May 18, 1980 event.[3]

**Figure 12-2. Potentially Active Volcanoes in the West**




Source: United States Geological Survey.
http://www.volcano.si.edu/reports/usgs/maps.cfm#usa

## History of Volcano-Related Events Affecting Beaverton

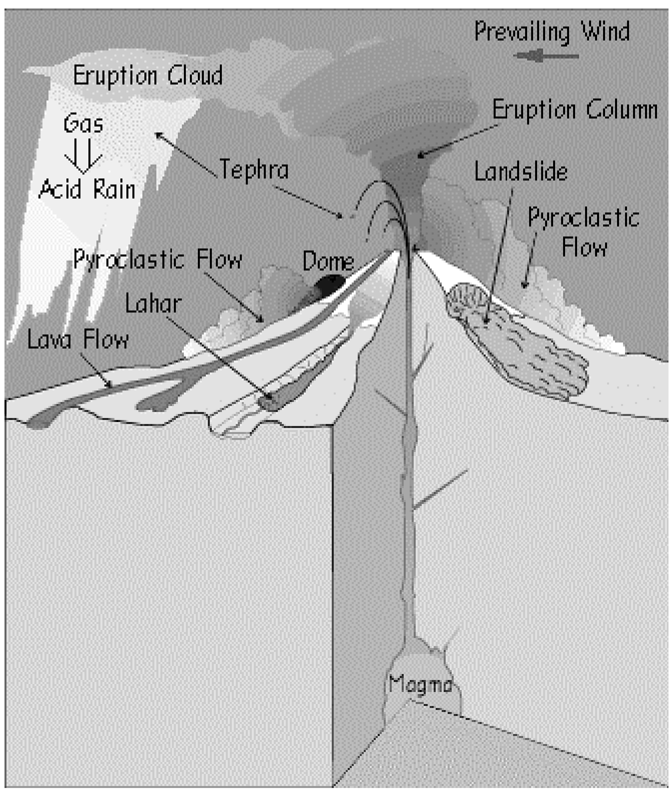
The only historical incidence of a volcano directly affecting Beaverton was the eruption of Mount St. Helens on May 18, 1980. The Beaverton *Valley Times* followed the story of "mountain watchers" who watched the volcano from a campground near Cougar, Washington, throughout the spring of 1980. The eruption resulted in massive mudflows, floods and other land-changing forces."[4] Ash from the eruption clouded the air in the Portland Metropolitan area, but did not ultimately cause damage in Beaverton. Emergency management in Washington County was prepared for the ash by providing facemasks and preparing for road closures. Because wind direction continued to head to the east after the eruption, Beaverton escaped significant accumulations of ash fall.[5]

A few millimeters of ash fell onto Beaverton during small events on May 25, June 12, and October 16-18, 1980. The May 25 event left ash covering buildings, vehicles, lawns, and streets. For days, even weeks afterward, residents and government officials worked to clear away the fine powder and local hospitals treated a large number of patients suffering from respiratory problems attributed to the ash. They handed out surgical masks to help filter the ash, but the masks were largely ineffective. Residents and government officials worked aggressively to remove the ash deposits by flushing them into storm drains or sweeping them up and hauling them to landfill sites. Parks and outdoor swimming pools were particularly hard hit, requiring pool drainage and frequent filter cleaning. Ash also worked its way into equipment causing premature failures or requiring unscheduled maintenance.[6]

## Hazards Related to Volcano-Related Events

This section describes hazards related to Volcano-Related Events. Figure 12.3 shows a cross-section of a volcano and some of the hazards associated with volcanoes.

### Figure 12-3. Cross section of a volcano




Source: United States Geological Survey.
http://volcanoes.usgs.gov/Hazards/What/hazards.html

### Tephra

Tephra consists of sand-sized or finer particles of volcanic rock and larger fragments. During explosive eruptions, tephra, together with a mixture of hot volcanic gases, is ejected rapidly into the air from volcanic vents. The suspended materials are carried high into the atmosphere and begin to move downwind. As the ash particles cool or become moisture laden they start to fall under the influence of gravity. The larger fragments fall near the volcanic vent, while finer particles drift downwind as a large cloud and then fall to the ground to form a blanket-like deposit of ash.[7]

Tephra generates a number of hazards including the impacts of falling fragments, the suspension of abrasive particles in the air and water, and the burial of structures, transportation routes, and vegetation. Tephra can also threaten public health, clog drainage and facility ventilation systems, clog the air intakes of internal-combustion engines (especially vehicles), and create major debris management problems. The 1980 eruption of Mount St. Helens, for example, injected tephra to altitudes of twelve to twenty miles and deposited it over an area of 40,000 square miles or more. The direction and velocity of the wind, along with the magnitude and duration of the eruption, determine the location, size, and shape of the tephra fall. Wind forecasts from National Weather Service and models of ash dispersal developed by volcanologists can provide short-term forecasts for areas that might be subject to ash fall.[8]

As indicated, ash fall can have significant impacts on water drainage systems. The accumulation of ash in Beaverton's drainage system from the 1980 eruption of Mount St. Helens resulted in the accumulation of a cement-like substance, which has reduced the capacity of the system over time. Beaverton must be aware of the potential tephra hazards that can arise from eruptions at nearby volcanoes.

### Lahars

Melting snow and ice caused by pyroclastic flows and surges can generate lahars, also called volcanic mudflows or debris flows. Lahars are rapidly flowing, water-saturated mixtures of mud and rock fragments. Lahars range in consistency from mixtures resembling freshly mixed concrete to very muddy water, and can carry materials as large as truck size boulders. Past lahars at Mount Hood completely buried valley floors in the Sandy, Hood, and White River drainages. Beaverton is not at risk from lahars. However, water from the Bull Run Watershed, which supplies drinking water to about 15% of Beaverton residents, could be affected directly or indirectly by lahars from Mount Hood.[9]

### Lava Flows

Magma under the Earth that reaches the surface is called lava. Lava flows downhill and is channeled into river valleys. A lava flow only affects terrain that is down-slope from its vent. While lava flows are destructive, they are not normally life threatening. There are ninety-five named and unnamed Boring

> For more information on the Boring Lava Field in Portland, Oregon, visit:
>
> http://vulcan.wr.usgs.gov/Volcanoes/Oregon/BoringLavaField

Lava Field vents in the Portland area. The Swede Hill area, on the northeastern side of Beaverton, has seven vent locations, with four of them named.[10] There is a very low probability of a Volcano-Related Events beginning in Beaverton. However, if an eruption occurred, it would likely be effusive and form lava flows.[11]

### Earthquakes

Volcanic eruptions can both be triggered by earthquakes and can cause them. An earthquake produced by stress changes in solid rock from injection or withdrawal of magma (molten rock) is called a volcano-tectonic earthquake. The other categories of volcanic earthquakes, called long period earthquakes, are produced by the injection of magma into surrounding rock. Volcanic earthquakes tend to be mostly small and not a problem for areas tens of miles from the volcano. For specific hazards related to earthquakes, see Chapter 11 of this document.

### Directed Blasts, Pyroclastic Flows and Volcanic Landslides

Directed blasts, also known as lateral blasts, are sideways-directed volcanic explosions that can shoot large pieces of rock at high speeds for several miles.[12] Pyroclastic flows are fluid mixtures of hot rock fragments, ash, and gases that sweep down the flanks of volcanoes. Landslides, or debris avalanches, are a rapid downhill movement of rocky material, snow, or ice.[13] Though these hazards could cause great impact to communities near an erupting volcano; they do not pose a threat to Beaverton resident.

## Community Volcano-Related Events Issues

Volcano-Related Events are not immediate threats to the residents of Beaverton, as there are no active volcanoes within Washington County. Nevertheless, the presence of a few geologically young volcanic structures near Beaverton and the secondary threats caused by volcanoes in the Cascade region must be considered. Volcanic ash can contaminate water supplies, cause electrical storms, create health problems, and collapse roofs.[14] Additionally, lahars from Mount Hood could cause the loss of some potable water supplies for the city.

### Building and Infrastructure Damage

Beaverton is not within the major hazard zones of any Cascade volcanoes. It is not likely to encounter any major building or infrastructure damage where buildings could be buried, smashed, or carried away by lahar, pyroclastic flow, or landslide. The primary impacts facing city residents are related to ash fall.

Ash fall of about 0.4 inch is capable of creating temporary disruptions of transportation operations and sewage disposal and water treatment systems. Highways and roads could be closed for hours, days, or weeks afterwards. The impact of the ash fall caused the Portland International Airport to close for a few days during the eruption of Mt. St. Helens. The airport faced a series of challenges in cleaning up the ash that accumulated on its runways.

The fine-grained, gritty ash can also cause substantial problems for internal-combustion engines and other mechanical and electrical equipment. The ash can contaminate oil systems, clog air filters, and scratch moving surfaces. Fine ash can also cause short circuits in electrical transformers, which in turn cause power blackouts. Sewage disposal systems, high tech facilities, and other critical industries in Beaverton face these challenges.

### Pollution and Visibility

Ash fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice. High-altitude winds may carry finer ash from tens to hundreds of miles from the volcano, posing a hazard to flying aircraft, particularly those with jet engines.[15] Fine ash in water supplies will cause brief muddiness and chemical contamination. The Tualatin River and the Bull Run Watershed, which provide some of the drinking water for Beaverton residents, face potential pollution by ash fall. Air quality could also be affected. For individuals with breathing problems, a few millimeters of ash fall may cause difficulties in breathing.[16]

Ash fall also decreases visibility and disrupts daily activities. For example, some individuals may encounter eye irritation. Visibility is especially a concern for airports, where passenger and airfreight movement could be disturbed. When the ash fall produced by the Mount St. Helens' eruption started to blow towards Oregon in June 1980, some of the airlines at the Portland International Airport responded immediately by stopping their service. Hillsboro Airport, which lies near Beaverton and handles a large volume of private aircraft, would probably have to curtail or cease operations during an ash fall event.

### Economy

Volcano-Related Events can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, and cause rapid wear and tear of machinery, clog air filters, block drains, creeks, water intakes, and impact agriculture.[17] Removal and disposal of large volumes of deposited ash can also have significant impacts on government and business.

The interconnectedness of the region's economy can be disturbed after a Volcano-Related Events. The Mount St. Helens' May 1980 eruption had a negative affect on the tourism industry. Conventions, meetings, and social gatherings were canceled or postponed in cities and resorts throughout Washington and Oregon in areas not initially affected by the eruption.

Transportation of goods and people to and from Beaverton may be halted. Subsequent airport closures can disrupt airline schedules for travelers and airfreight shipments. Other transportation operations can be impacted as well. Clouds of ash often cause electrical storms that start fires and damp ash can short-circuit electrical systems and disrupt radio communication. Ash fall can directly or indirectly disrupt the light rail system and Tri-Met bus service. Volcanic activity can also lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates into an eruption.[18]

# Volcano-Related Events Hazard Assessment

## Hazard Identification

The USGS/Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997 as well as an update to the Mount Hood report in 2000. The reports include a description of potential hazards that may occur to immediate communities. In 2001, the CVO created an updated map on the annual probability of tephra fall for the Cascade region, which can be used by the City as a guide for forecasting potential tephra hazard problems.

The map is based on the combined likelihood of tephra-producing eruptions occurring at Cascade volcanoes. Probability zones extend father east of the range because winds blow from westerly directions most of the time. The map shows annual probabilities for a fall of one centimeter (about 0.4 inch). The patterns on the map show the dominating influence of Mount St. Helens as a tephra producer. Because small eruptions are more numerous than large eruptions, the probability of a thick tephra fall at a given location is lower than that of a thin tephra fall. The annual probability of a fall of one centimeter or more of tephra is about 1 in 10,000 on the county level, even less for the City.

## Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines information generated through hazard identification with an inventory of the existing development exposed to Volcano-Related Events. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.[19] Data that includes areas susceptible to ash fall in the City can be used to assess the population and total value of property at risk from Volcano-Related Events.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not been conducted for Beaverton Volcano-Related Events events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Beaverton faces no direct threat from a Volcano-Related Events. However, its proximity to a number of Cascade Range volcanoes places the City at risk from ash fallout originating from such an event.

**Future Activity at Mount Hood:** While Mount Hood has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of lava dome growth accompanied by small explosions, and lava-dome collapse generating pyroclastic flows, ash clouds, and lahars. Future eruptions from Mount Hood could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in northwestern Oregon and southwestern Washington.

The City also faces an indirect threat to a small percentage of its water supply based on a volcanic scenario impacting the Bull Run Water System. The impacts of a significant ash fall are substantial. Persons with respiratory problems are endangered, transportation, communications, and other lifeline services are interrupted, drainage systems become overloaded/clogged, buildings can become structurally threatened, ventilation systems can become clogged and the economy takes a major hit. Any future eruption of a nearby volcano (e.g., Hood, St. Helens, or Adams) occurring during a period of easterly winds would likely have adverse consequences for the City.

## Risk Analysis

Risk analysis is the third, and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessments. Key factors in assessing risk from volcanic-related evetns include population and property distribution in the hazard area, the frequency of events, and potential wind direction. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

# Existing Mitigation Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. The goals for the City of Beaverton Natural Hazards Mitigation Action Plan are broad based to include all of the identified hazards addressed in the plan. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Hazard Communication and Coordination through Partnerships
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations.

## City Programs

### Emergency Management Program

Beaverton's Office of Emergency Management maintains a web site with numerous links to information about volcanoes and the National Weather Service.

## County Programs

### Cooperative Public Agency of Washington County

Every city in Washington County belongs to the Cooperative Public Agency of Washington County (CPAWC). This agency allows cities within the county to share resources, such as equipment, labor, resources, and trainings before, during, and after emergency situations. Through Intergovernmental Agreements (IGA's), the cities can then bill each other for loaned equipment and services.[20]

## Federal Programs

### Monitoring Volcanic Activity at Mount Hood and Mount St. Helens

The USGS collaborated with scientists from the Geophysics Program at the University of Washington to monitor seismic activity at both Mount St. Helens and Mount Hood after the May 1980 eruption at Mount St. Helens.[18] When unusual activity is observed, scientists immediately notify government officials and the public. The U.S. Forest Service serves as the primary dissemination agency for emergency information. As the activity changes, USGS scientists provide updated advisories and meet with local, state, and federal officials to discuss the hazards and appropriate levels of emergency response. The experience since 1980 at Mount St. Helens and elsewhere indicates that monitoring is sufficient for scientists to detect the ascent of fresh magma that must take place before another large eruption. This information will enhance warnings and facilitate updated assessments of the hazard.

In addition, the USGS and the National Weather Service monitor lahar and flood hazards at Mount St. Helens. The latter agency has responsibility for providing warnings of floods, including lahars. These monitoring activities not only help nearby communities, but can also provide significant benefit to the Pacific Northwest, including Beaverton.

### Volcanic Event Notification Emergency Coordination

An emergency coordination center (ECC) was established at the US Forest Service (USFS) facility in Vancouver, Washington after the 1980 eruption of Mount St. Helens. A communications network and telephone call-down procedure was developed to facilitate rapid dissemination of information about the activity of the volcano. Information was also disseminated through public meetings, press conferences, and briefings with governmental agencies and private businesses. Currently, the system has the capability of issuing written predictions weeks in advance of most eruptions. This eliminates the need for 24-hour duty for both USFS/ECC and CVO staff except when eruptions are imminent. It can enter all predictions and updates into a computer "news" system for easy review by those on the call-down list; update volcanic activity reports when the volcano is quiet; and develop a seismic alarm to alert scientists to small events that occur without precursors.

### USGS Video Programs

One good example of education and outreach is the USGS series of videos related to Volcano-Related Events. The USGS has produced a video program “At Risk: Volcano Hazards from Mount Hood, Oregon.” The video describes and illustrates the types of volcanic hazards posed by Mount Hood, and shows areas near the volcano that could be affected by future activity. The video was produced to provide nearby residents, businesses, and public agencies basic information about future potential hazards from the volcano.[19]

### Decade Volcanoes

The Decade Volcanoes project began as part of the International Decade for Natural Disaster Reduction (IDNDR). The aim of the Decade Volcanoes project is to direct attention to a small number of selected, active volcanoes world-wide and to encourage the establishment of a range of research and public-awareness activities aimed at enhancing an understanding of the volcanoes and the hazards posed by them. Mount Rainier, in the Cascade Range, has been designated one of the Decade Volcanoes.[21]

## Volcano-Related Events Mitigation Action Items

The Volcano-Related Events mitigation action items provide direction on specific activities that the City, organizations and residents can undertake to reduce risk and prevent loss from volcanic events. There are two short-term and two long-term volcanic action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

**ST-VE#1: Identify critical facilities and industries that may be affected by ash fall and collaborate with them on ash fall emergency response.**

***Ideas for Implementation***

- Collaborate and exchange experiences and knowledge among facility managers of critical industries in the region to reduce the impact of ash fall on their sites.

**Coordinating Organizations:** City of Beaverton
**Internal Partners:** Emergency Management, Operations and Maintenance Department

**External Partners:** United States Geological Survey– Cascades Volcano Observatory (USGS-CVO), Major Industries, Department of Geology and Mineral Industries (DOGAMI), United States Forest Service (USFS), Utility Providers, Federal Emergency Management Agency (FEMA)
**Timeline:** 1-2 years
**Plan Goals Addressed:** Improve Partnerships for Communication and Coordination, Enhance Emergency Services

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### ST-VE#2: Collaborate with USGS-CVO and related agencies to increase awareness of volcanic response efforts through ash fall related messages.

#### *Ideas for Implementation*

- Collaborate with USGS-CVO, OCEM, FAA, National Weather Service, law enforcement offices, and the media to develop a warning message framework that is more appropriate for the area so that communities and individuals have a clear sense of how to respond;
- Continually update information, monitor and track in the event of a volcanic emergency; and
- Educate residents on what to do and where to go in the event of a volcanic event in the Cascades.

**Coordinating Organizations:** City of Beaverton
**Internal Partners:** Emergency Management
**External Partners:** United States Geological Survey – Cascades Volcano Observatory (USGS-CVO), Federal Aviation Administration (FAA), Department of Geology and Mineral Industries (DOGAMI), Oregon Emergency Management (OEM), National Weather Service, law enforcement offices, local media, Regional Emergency Management Technical Committee (REMTC), Federal Emergency Management Agency (FEMA) Region 10 Volcanic Working Group, Tualatin Valley Fire and Rescue District, School Districts
**Timeline:** Ongoing
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards; Improve Partnerships for Communication and Coordination

**LT-VE#1: Map and model ash fall.**

***Ideas for Implementation***

- Map and model ash fall to assist in interpreting potential scenarios, including prevailing winds that could impact Beaverton.

**Coordinating Organizations:** City of Beaverton
**Internal Partners:** ISD/GIS
**External Partners:** United States Geological Survey – Cascades Volcano Observatory (USGS-CVO), Department of Geology and Mineral Industries (DOGAMI), National Weather Service, Washington County
**Timeline:** 1-5 years
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

**LT-VE#2: Establish a plan for ash removal following a volcanic event.**

***Ideas for Implementation***

- Educate residents on what they can do to assist in clean-up and debris removal efforts following a volcanic event;
- Assist the public in removing ash by developing a system for ash removal; and
- Develop public and private partnerships to ensure proper clean-up.

**Coordinating Organizations:** City of Beaverton
**Internal Partners:** Emergency Management, Operations/Maintenance Department
**External Partners:** Washington County, Waste Management
**Timeline:** 1-5 years
**Plan Goals Addressed:** Develop and implement activities to protect human life, commerce, property, and natural systems from natural hazards

# Volcano-Related Events Resource Directory

## City Resources

### City of Beaverton Emergency Management Program

The City of Beaverton Emergency Management Program is responsible for preparing for and responding to various types of emergencies within in Beaverton, including natural disasters.

**Contact:** Emergency Manager
**Address:** 20665 SW Blanton St., Aloha
**Phone:** (503) 642-0383
**Website:** http://www.ci.Beaverton.or.us/departments/emergency
**Email:** emergmngmail@ci.Beaverton.or.us

### City of Beaverton Operations and Maintenance Department

The City of Beaverton's Operations and Maintenance Department is responsible for maintaining the integrity of the city's infrastructure, including roadways, storm drainage, water quality facilities, and landscapes, all of which may be affected by ash fall from a Volcano-Related Events.

**Contact:** Operations Director,
**Address:** 9600 SW Allen Blvd., Beaverton, OR.
**Phone:** (503) 526-2220
**Website:** http://www.ci.Beaverton.or.us/departments
**Email:** opsmail@ci.Beaverton.us.or

### Finance Department

The Information Systems Department is part of the Finance Department and includes GIS Services.

**Contact**: Finance Director
**Address**: 4755 SW Griffith Dr., Beaverton, OR 97005
**Phone**: (503) 526-2435
**Website**: www.ci.beaverton.or.us/departments/finance/
**Email**: financemail@ci.beaverton.or.us

## County Resources

### Washington County Office of Emergency Management

The Washington County Emergency Management Program exists pursuant to ORS 401 to guide the county's preparations for, response to, and recovery from major emergencies and disasters. The program is organized under the county sheriff's office and oversees preparation and maintenance of the county's emergency operations plan and emergency operations center and the training and exercising of designated staff. Unique to Washington County is a consolidated office that brings the emergency management staffs from four jurisdictions together into a single office to enhance disaster preparedness activities countywide. The Office of Consolidated Emergency Management (OCEM) for Washington County was formed in 1995 by Intergovernmental Agreement between Washington County, the cities of Beaverton and Hillsboro, and Tualatin Valley Fire and Rescue. The organization's mission statement indicates that "The Office of Consolidated Emergency Management for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters."

**Contact:** Director, Washington County Emergency Management
**Address:** 20665 SW Blanton St. Aloha, OR, 97007
**Phone:** (503) 642-0371
**Website:** http://www.ocem.org
**Email**: info@ocem.org

## State Resources

### Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to natural hazards, with flood as its major focus. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide-related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance such as conducting workshops, reviewing local land use plan amendments, and working interactively with other agencies.

**Contact:** Natural Hazards Program Manager
**Address:** 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
**Phone:** (503) 373-0050
**Fax:** (503) 378-6033
**Website:** http://www.lcd.state.or.us/hazards.html

### Oregon State Police (OSP)-Office of Emergency Management (OEM)

The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing, and providing for the prevention, mitigation, and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the state of Oregon.

**Contact:** Office of Emergency Management
**Address:** 595 Cottage Street NE, Salem, OR 97310
**Phone:** (503) 378-2911
**Fax:** (503) 588-1378
**Website:** http://www.osp.state.or.us/oem

## Federal Resources

### USGS-David A. Johnston Cascades Volcano Observatory (CVO)

CVO provides accurate and timely information pertinent to assessment, warning, and mitigation of natural hazards. It provides warnings during volcanic crises by monitoring volcanoes and interpreting results in the context of current hazard assessments. It also provides information for use in land-use management emergency response plans, and public education.

**Contact:** CVO
**Address:** 5400 MacArthur Blvd, Vancouver, WA 98661
**Phone:** (360) 993-8900
**Fax:** (360) 993-8980
**Website:** http://vulcan.wr.usgs.gov/CVO_Info/framework.html

### National Weather Service, Portland Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector, the public, and the global community.

**Contact:** National Weather Service
**Address:** 5241 NE 122nd Ave, Portland, Oregon 97230
**Phone:** (503) 326-2340
**Website:** http://nimbo.wrh.noaa.gov/Portland

### Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) is an independent agency of the federal government, reporting to the President. FEMA's purpose is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA provides disaster relief funds following a natural hazard and works closely with the Oregon State Police - Office of Emergency Management.

**Contact:** Public Affairs Officer
**Address:** 130 228th Street, St., Bothell, WA 98021-9796
**Phone:** (425) 487-4610
**Fax:** (425) 487-4690
**Website**: http://www.fema.gov/library/volcano.htm
**Email:** opa@fema.gov

## Additional Resources

### American Red Cross

The American Red Cross is a humanitarian organization, led by volunteers, that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area, including disaster planning, preparedness, and education.

**Contact:** American Red Cross, Oregon Trail Chapter
**Address:** P.O. Box 3200, Portland, OR 97208-3200
**Phone:** (503) 284-1234
**Fax:** (503) 284-4247
**Website:** http://www.redcross-pdx.org
**Email:** info@redcross-pdx.org

### Institute for Business & Home Safety (IBHS)

IBHS was created as an initiative of the insurance industry to reduce damage and losses caused by natural disasters. Their website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

**Contact:** Institute for Business and Home Safety
**Address:** 1408 North Westshore Boulevard - Suite 208, Tampa, FL 33607
**Phone:** (813) 286-3400
**Fax:** (813) 286-9960
**E-mail:** info@ibhs.org
**Website:** http://www.ibhs.org/ibhs2

### Institute of Geological & Nuclear Sciences Limited (GNS)

GNS has an excellent website that describes volcanic hazards in New Zealand. It provides simple and informative descriptions of volcanic hazards that are useful for communities around the world. It discusses the types of volcanic hazards and emergency response and mitigation actions that could be implemented.

**Contact:** Institute of Geological & Nuclear Sciences
**Address:** 69 Gracefield Rd, PO Box 30-368, Lower Hutt, New Zealand
**Phone:** (04) 570-1444
**E-mail:** info@ibhs.org
**Website:** http://www.gns.cri.nz/earthact/volcanoes/hazards/index.htm

## Publications

*Volcanic-Hazard Zonation for Mount St. Helens*, Washington Open-File Report 95-497 (1995) USGS-CVO Produced by the USGS-CVO in 1995, this report explains the various hazardous geologic processes of Mount St. Helens and the types of hazards and damages that have occurred at Mount St. Helens. It also includes valuable references and suggested reading.

**Contact:** USGS-CVO
**Address:** 5400 MacArthur Blvd, Vancouver, WA 98661
**Phone**: (360) 993-8900
**Fax:** (360) 993-8980
**Website:** http://vulcan.wr.usgs.gov/Volcanoes/MSH/Hazards

*Volcano Hazards in the Mount Hood Region*, Oregon Open-File Report 97-89 (1997) USGS-CVO

Produced by the USGS-CVO in 1997, this report documents past hazardous events that have occurred at Mount Hood and includes several volcano hazard maps. It also discusses hazard forecasts and warnings as well as ways to protect oneself from volcano hazards.

**Contact:** USGS-CVO
**Address**: 5400 MacArthur Blvd, Vancouver, WA 98661
**Phone:** (360) 993-8900
**Website:** http://vulcan.wr.usgs.gov/Volcanoes/MSH/Hazards

*Public Assistance Debris Management Guide*, Federal Emergency Management Agency (July 2000).

Debris management is generally associated with post-disaster recovery. While debris management should be compliant with local and county emergency operations plans, developing management strategies to ensure strong debris management during and after a natural hazard event is a way to integrate debris management with mitigation. The *Public Assistance Debris Management Guide* is available in hard copy or on the FEMA website.

**Contact:** FEMA Distribution Center
**Address**: 130 228th Street, SW, Bothell, WA 98021-9796
**Phone:** (800) 480-2520
**Fax**: (425) 487-4622
**Website:** http://www.fema.gov/r-n-r/pa/dmgtoc.htm

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## Volcano-Related Events Endnotes

[1] Tilling, et.al.,1990. http://www.Vulcan.wr.usgs.gov/Volcanoes/MSH/Hazards
[2] *Volcanic Hazard Zonation for Mount St. Helens, Washington* (1995), USGS, Open-File-Report 95-497.
[3] Community Planning Workshop, 2002
[4] The Valley Times, May 21, 1980. Vol.60 No.37.
[5] The Valley Times, May. 23, 1980. Vol.60 No.38
[6] Community Planning Workshop, 2002
[7] Ibid
[8] Ibid
[9] The City of Beaverton web site http://www.ci.Beaverton.or.us
[10] *Volcano Hazards of the Lassen Volcanic National Park Area,* (March 2001), USGS.
[11] Community Planning Workshop, 2002
[12] Volcanoes (March 2001), FEMA, www.fema.gov/library/volcano.htm
[13] Wright and Pierson, *Living with Volcanoes,* (1973, 1992) USGS Volcano Hazards Program Circular
[14] Ibid
[15] Ibid
[16] Ibid.
[17] Ibid.
[18] Personal Interview. Cashman, Kathy, University of Oregon Department of Volcanology, March 14, 2001.
[19] Burby, R. (Ed.). Cooperating with Nature. (1998). Washington D.C. Joseph Henry Press.
[20] Personal Interview. Pete Davis, City of Beaverton Operation, March 14, 2003.
[21] United States Geologic Survey – Cascades Volcano Observatory.
http://volcano.und.nodak.edu/vwdocs/volc_images/decade/

# Appendix A
# Public Participation

Public participation is an important component of this natural hazard Mitigation Plan. Public participation offers citizens the chance to voice their ideas, interests and opinions. Oregon's land use system addresses the need for public process in Statewide Land Use Planning Goal 1: Citizen Involvement, which ensures the opportunity for citizens to be involved in the planning process. FEMA's Disaster Mitigation Act of 2000 includes new requirements for involving the public in natural hazard mitigation planning. The Act requires:

"An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and no-profit interests to be involve in the planning process."[1]

The Beaverton Natural Hazard Mitigation Plan was developed with input from a variety of public participation techniques including: a steering committee composed of key stakeholders, stakeholder interviews, surveys of Beaverton households and businesses, and two focus group meetings. Integrating public participation in the Beaverton Natural Hazard Mitigation Plan resulted in an increase in public awareness about natural hazard preparedness and risk reduction as well as the plan development process and mitigation opportunities plan. The participation process also allowed for the development of action items that reflect community issues and concerns, as well as new ideas and perspectives. The following is a brief description of each of the four techniques that were implemented in Beaverton. Specific results from the household and business surveys and the focus groups can be found in the following appendices.

## Steering Committee

A diverse steering committee took an advisory roll in the process of creating the plan. Members of the steering committee came from government services, nonprofit organizations, public utilities and businesses in the Beaverton area. Because of their role in the community of Beaverton, their knowledge about community issues helped make the plan specific and relevant to the community. The steering committee recommended stakeholders to contact for interviews, brainstormed city capabilities, identified areas at risk to natural hazards in Beaverton and critical facilities that may be affected or play a role in response, and helped to craft goals and action items. Table A-1 lists the various people and organizations that participated on the Beaverton Natural Hazard Mitigation Plan Steering Committee.

**Table A-1. Mitigation Plan Steering Committee**

| Name | Organization |
|---|---|
| Dave Ford | Portland General Electric |
| David Gassaway | American Red Cross – Oregon Trail Chapter |
| Barbara Fryer | City of Beaverton, Community Development Department |
| Pete Davis | City of Beaverton, Operations and Maintenance Department |
| Brad Roast | City of Beaverton, Community Development Department |
| Jerry Williams | City of Beaverton, Engineering Department |
| Suzanne Carey | City of Beaverton, Community Development Department |
| Michael Mumaw | City of Beaverton, Emergency Management Program |
| Linda Adlard | City of Beaverton, Chief of Staff |
| Kevin Hohnbaum | Community Newspapers |
| Doug Taylor | City of Beaverton, Geographic Information Systems Services |
| Tracey Rigby | City of Beaverton, Geographic Information Systems Services |
| Scott Porter | Office of Consolidated Emergency Management Services |

### Steering Committee Meeting #1: October 2, 2002

Oregon Natural Hazards Workgroup (ONHW) and Community Planning Workshop (CPW) provided an overview to the steering committee about the Community Service Center, CPW, and ONHW at the University of Oregon. ONHW/CPW also presented project methodology along with the draft plan framework. Steering Committee members were asked to fill out a questionnaire about their expectations about the project as well as their organization's current role in hazard mitigation.

### Steering Committee Meeting #2: December 5, 2002

ONHW provided an update on completed and current activities and presented information about the development of the plan goals (Chapter 4). The Steering Committee looked at the plan goals from the Washington County Natural Hazard Mitigation Plan and brainstormed potential goals for the Beaverton plan. The household and business survey instrument was presented to the committee for comment.

### Steering Committee Meeting #3: February 11, 2003

ONHW presented the project update of the project including progress on the survey, issue identification and stakeholder interviews.

Comments were collected on the draft issues and actions and amendments were made to the draft goals from the previous meeting. The bulk of the meeting was spent on a community mapping exercise where the committee was asked to identify on maps the location of the following: critical facilities, human populations, cultural assets, economic assets, and environmental assets. The results of the mapping exercise were used to identify vulnerable areas within the City and also helped to identify additional natural hazard related issues.

### Steering Committee Meeting #4: April 16, 2003

This meeting focused on developing the plan's action items. The action item methodology was presented. Sources of information for action items include: community profile, risk assessment, hazard specific chapters, issue identification, the Washington County plan, citizen focus groups, stakeholder interviews, capability assessment, business survey, and the household survey. The committee also brainstormed issues and potential actions for three hazards – flood, earthquake and windstorm.

### Steering Committee Meeting #5: May 21, 2003

During the fifth meeting, the steering committee reviewed and commented on the draft hazard specific action items including: flood, windstorm, severe winter storm, earthquake, and volcanic eruption. The committee suggested combining wind and winter storm into a severe weather chapter. Comments were collected from the steering committee for revision.

### Steering Committee Meeting #6: June 4, 2003

This meeting was a continuation of the previous meeting. The steering committee reviewed and commented on all of the hazard specific action items from the previous meeting as well as the action items for wildfire and landslide.

### Steering Committee Meeting #7: June 25, 2003

The committee discussed the multi-hazard action items. Draft action items were provided to the committee two weeks before the meeting to allow time to review them.

### Steering Committee Meeting #8: July 29, 2003

At this meeting the steering committee agreed to a process by which the plan's action items would be prioritized. This process called on the committee to prioritize the plan goals and discuss how the information would be presented.

## Stakeholder Interviews

Stakeholders interviewed for the mitigation plan represented agencies and organizations throughout the City. ONHW integrated information provided by stakeholders into the sections of the plan relating to current mitigation activities, new action items, and in the resource directory. Table A-3 lists the stakeholders that ONHW interviewed during development of the mitigation plan.

**Table A-3. Mitigation Plan Stakeholders**

| Name | Organization |
|---|---|
| Janelle St. Pierre | Tualatin Valley Watershed Council |
| Dale Fishback | Tualatin Valley Water District |
| Pam Herinckx | Soil & Water Conservation District |
| Krista Fischer | Insurance Information Service of Oregon and Idaho |
| David Gassaway | American Red Cross |
| Sue Marshal | Tualatin Riverkeepers |
| Dean Moberg | Natural Resource Conservation Service |
| Kendra Smith | Clean Water Service |
| Mike Mumaw | City of Beaverton EM |
| Jeff Rubin | Washington County EM |
| Pete Davis | City of Beaverton Operations |
| Brad Roast | City of Beaverton Buildings Official |
| Jerry Williams | City of Beaverton Engineering |
| Barbara Fryer | City of Beaverton Planning |
| Suzanne Carey | City of Beaverton Planning |
| Janet Young | City of Beaverton Economic Development |
| Keith Stone | City of Beaverton Storm Drainage |
| Mark Boguslawski | City of Beaverton Project Engineer |
| Jerry Green | Beaverton School District |
| Barbra Levy | Fox 49 Television Station |
| Larry Hatch | Washington County 911 Center |
| Kevin O'Keefe | City of Beaverton Police |
| Jordis Jensen | Northwest Natural Gas |
| Steve Woolley | Nike |
| Ed Bonello | Tualatin Fire Service Agency |

# Risk Perception Surveys

ONHW conducted a household and business survey in Beaverton in an effort to gain public input on the mitigation planning process. The purpose of the household survey was to gain information on risk perception, preparedness and risk reduction activities, preferences on community-wide goals and implementation strategies as well as demographic characteristics of the respondents. The purpose of the business survey was to gain information on critical business services, natural hazard impact, useful mitigation activities, and level of preparedness.

Surveys were mailed to businesses and residents in January 2003 and surveys were accepted until March 2003. The results of the household survey can be found in Appendix B and the results of the business survey can be found in Appendix C.

# Focus Groups

Focus groups were chosen because (1) they could be used to further gather data related to the household risk perception survey, (2) they are flexible and allow communities to gain direct feedback from citizens on hazard mitigation issues and priorities, (3) it allows stakeholders to interact with one another and build concepts and ideas based on comments and suggestions made by other participants, and (4) it provides an opportunity for citizens to prioritize community-level goals and implementation strategies.

Three focus groups were conducted during the process of making the plan between April 16 and April 22, 2003. A total of 14 people attended the focus groups. The focus group process was divided into two main sections including a discussion section covering preparedness, risk reduction activities, willingness to prepare, and community wide strategies. The second portion of the session included a role playing activity where participants were asked to assume the role of a City Councilor and had to prioritize generic planning goals and implementation strategies. The results of the focus group can be found in Appendix D.

To collect data on all four of the identified themes, the 90-minute focus group session was broken into two sections. The first component, modeled after the focus group technique, included a discussion on the first three main issues - household risk perception, household preparedness and willingness to reduce risk. The second component, modeled after citizen involvement workshops, included an activity that required participants to prioritize both community planning goals and implementation strategies. For the purposes of this report, the term focus group is used rather than workshop.

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### Appendix A Endnotes

[1] Code of Federal Regulations. 44CFR201 and 44CFR206

# Appendix B

# Household Natural Hazards Preparedness Survey

ONHW conducted a household preparedness survey in Beaverton with funding provided by the City. The survey asked Beaverton residents to consider natural hazards; whether they were concerned about them, how they have been affected by them; and what if anything, they have done to prepare for them. This survey allowed citizens to become better informed on what the city is doing to reduce risks within the community and what actions it could still undertake. This helped satisfy public participation requirements while also allowing for public values to be incorporated into the planning process. Understanding how the community views natural hazards is an important part of the natural hazard mitigation process. Examining people's attitudes about hazards may help to identify gaps in preparedness, and ways in which public/private coordination could be improved within the City.

## Methods

ONHW adapted this survey from one previously implemented statewide as part of the development of the Partners for Disaster Resistance Strategic Plan. The survey went through multiple review processes and was field-tested for readability and content. Input from the field test and the project steering committee refined the survey further before its distribution. Questions regarding community priorities for general natural hazard planning goals as well as implementation strategies were added to this survey in an effort to evaluate potential public support. The survey addressed the following topics:

- Demographics
- Perception of risk
- Level of preparedness
- Risk reduction activities
- Prioritization of community-wide planning goals and implementation strategies

A total of three mailings were made to survey recipients during the months of January and February 2003. The first mailing included a cover letter, a one-page educational flier on hazard preparedness, a survey and a business reply envelope. Ten days later, a reminder postcard was sent to all households asking them to return the survey if they had not yet done so and thanking them if they already had. Three weeks after the initial survey mailing, a second mailing was sent to those who had not yet responded to the survey. This particular methodology was chosen to help maximize responses. ONHW distributed 1,500 surveys to households located in Beaverton. The sample list was provided by Qwest.[1] ONHW received 320 valid responses, which yielded a 24% response rate.

## Limitations of Sampling Methodology

This survey identifies key issues about how residents perceive their risk from natural hazards in Beaverton. Moreover, it is a snapshot of perceptions at a single point in time. As such, survey responses may reflect external issues, such as terrorism threats or recent occurrences of natural hazards. The survey was not intended to be representative of the perceptions of all Beaverton residents.

Another limitation of the study's methodology is potential non-response bias from the mailed survey. If one were to assume that the sample was perfectly random and that there was no response bias, then the survey would have a margin of error of ±5% at the 95% confidence level. This means that if the survey were conducted 100 times, the results would end up within ±5% of those presented in this report.

Non-response bias is an issue in all surveys, but is particularly important in mailed surveys due to response rates. The Household Natural Hazards Preparedness Questionnaire had a 24% response rate. The question that we cannot answer with 100% confidence is whether those 24% are representative of the entire population, or of some portion of the population that holds a different set of opinions.

## Organization of Survey Findings

This appendix is organized into the following sections:

***Demographics:*** This section describes the characteristics of survey respondents and compares the survey results with selected demographic variables from the 2000 U.S. Census.

***Risk Perception:*** This section creates a profile of survey respondents and identifies:

- The hazards that respondents have experienced;
- Their general level of concern over natural hazard risks;
- The types of natural hazards present in Beaverton;
- Respondents' perceptions of threats posed by natural hazards;
- Perceptions of various education and outreach material in raising natural hazard awareness; and
- Preferred avenues for information dissemination.

***Level of Preparedness:*** This section provides an overview of natural hazard preparedness activities at the household level in Beaverton.

***Risk Reduction Activities:*** To better understand the actions that Beaverton residents are undertaking to protect their homes from disaster, the survey asked respondents to provide information about their risk reduction activities. This section describes the types of structural and nonstructural measures that are being implemented by survey respondents, and the types of resources or programs that might increase risk reduction activities.

***Community-wide planning goals and implementation strategies:*** This section helped to determine citizen priorities for planning for natural hazards as well priorities for implementation strategies aimed at reducing risk.

***Survey Results:*** Included at the end of this appendix are the results from the Household Natural Hazard Preparedness Survey. A listing of written comments on community issues and general comments are also included.

# Demographics

Demographic questions provide a statistical overview of the characteristics of respondents. This section of the survey asked respondents about their age and gender, their level of education, and how long they have lived in Oregon. The survey also included questions regarding respondents' present housing. Where appropriate, the results are compared with 2000 Census data to illustrate differences in the sample population and the overall City population.

## Age and Gender

Men accounted for 49.2% of survey respondents – a result that mirrors Beaverton's population (the 2000 Census indicates Beaverton's population was approximately 49.4% male). Table B-1 compares the percentage of survey respondents by age to the percent reported in the 2000 Census. Note that the survey sample included only persons age 18 and over. Note that the survey under represents persons under age of 34 and over represents persons age 35 and over compared to the population of Beaverton.

**Table B-1. Percentage of Beaverton Population and Survey Respondents in Each Age Classification (persons 15 and over)**

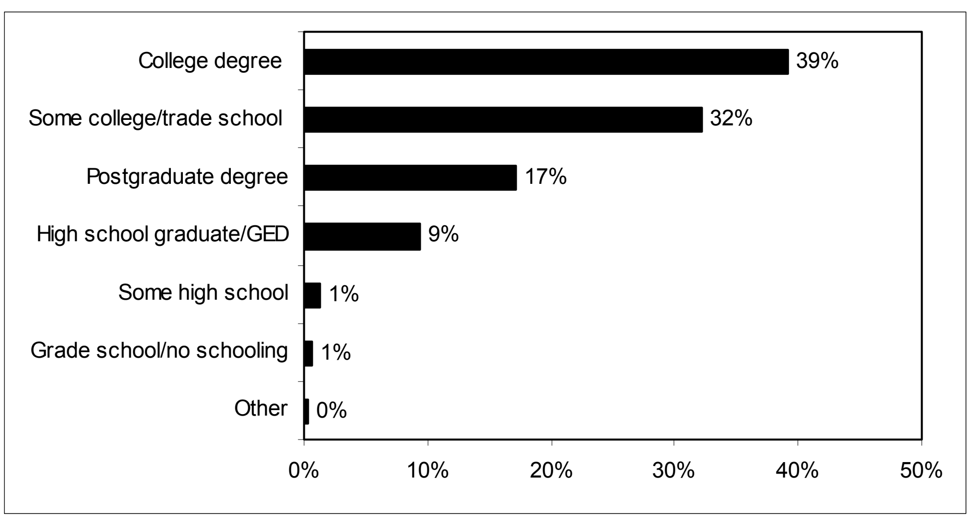
| Age Category | Beaverton | Percent of Respondents |
|---|---|---|
| 15 to 19 years | 6.3% | 0.0% |
| 20 to 24 years | 8.1% | 0.3% |
| 25 to 34 years | 18.4% | 15.2% |
| 35 to 44 years | 16.7% | 21.7% |
| 45 to 54 years | 13.6% | 24.5% |
| 55 to 59 years | 4.1% | 9.9% |
| 60 to 64 years | 2.7% | 7.5% |
| 65 to 74 years | 4.0% | 9.9% |
| 75 to 84 years | 3.4% | 6.8% |
| 85 years and over | 1.5% | 1.9% |

Source: U.S. Census Bureau: www.census.gov (2000) and ONHW/CPW, Beaverton Household Risk Perception Survey, (January 2003)

## Level of Education

Survey respondents were relatively well educated compared to the overall population of Beaverton. Eighty-eight percent of survey respondents have had some college or trade school, or have a college degree or postgraduate degree (see Figure B-1). The US Census Bureau estimates that in 2000 in Beaverton, 72% of people had some college, an associate degree, a bachelor's degree or a postgraduate degree. Therefore, survey respondents were more likely to have completed a higher educational level than the overall Beaverton population. The survey also under represented those with less than a high school education or a high school diploma.

**Figure B-1. Level of Education**

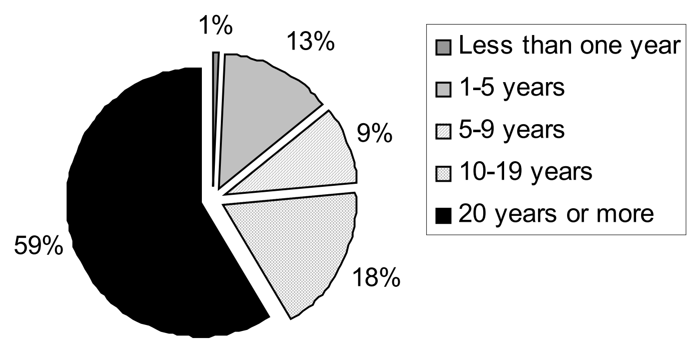



Source: U.S. Census Bureau: www.census.gov (2000) and ONHW/CPW, Beaverton Household Risk Perception Survey, (January 2003)

## Oregon Residency

The majority of survey respondents, 59% have lived in Oregon for 20 years or more (see Figure B-2). Respondents who have lived in Oregon for fewer than 20 years have most commonly moved from California (27%), Washington (12%), and Idaho (3%).

### Figure B-2. Length of Time Respondents Have Lived in Oregon




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

## Housing Characteristics

Eighty-four percent of survey respondents are homeowners. This percentage over represents the number of homeowners and under represents the number of renters, as illustrated in Table B-2 below.

### Table B-2. Percentage of Beaverton Population and Survey Respondents who own or rent their home

| Occupied housing units | Beaverton | Percentage of Respondents |
|---|---|---|
| Owner-occupied housing units | 48% | 84% |
| Renter-occupied housing units | 52% | 16% |

Source: U.S. Census Bureau: www.census.gov (2000) and ONHW/CPW, Beaverton Household Risk Perception Survey, (January 2003)

As illustrated in Table B-3, 72% of respondents own a single-family home while only 3% of renters occupy a single-family home. Twenty percent of respondents reported living in apartments with either three to four or 5 or more units or condominiums/townhouses.

**Table B-3. Dwelling Occupied by Respondents Who Own/Rent**

| Type of Dwelling | Own | Rent | Total |
|---|---|---|---|
| Single-family | 72% | 3% | 75% |
| Duplex | 1% | 1% | 3% |
| Apartment 3-4 Units | 0% | 3% | 3% |
| Apartment 5 or More Units | 0% | 8% | 8% |
| Condominium/Townhouse | 8% | 1% | 9% |
| Manufactured Home | 2% | 0% | 2% |
| Other | 0% | 0% | 0% |
| Total | 84% | 16% | 100% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, (January 2003)

# Risk Perception

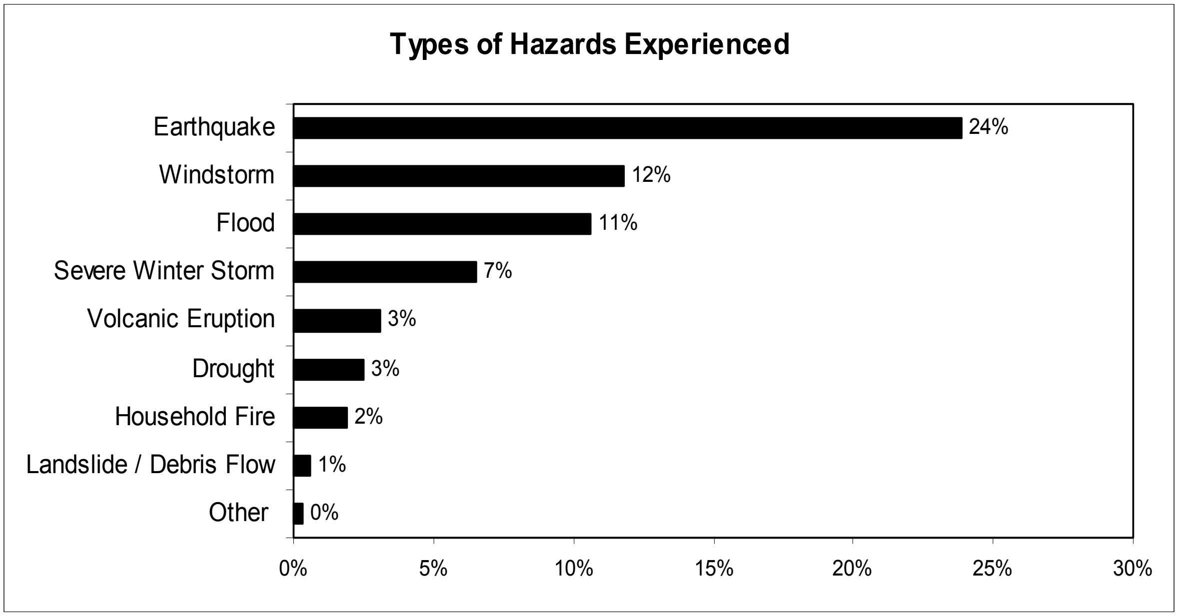
To make informed decisions about natural hazard risk reduction, it is essential to understand the population's experiences and perceptions of natural hazards. The survey asked respondents for information regarding their personal experiences with natural disasters and their level of concern for specific hazards in Beaverton. The primary objective of these questions was to create a natural hazard profile of respondents to better understand how Beaverton residents perceive natural hazards.

To understand the effectiveness of current outreach activities regarding home and family safety, the survey asked respondents about the types of information they receive on how to make their home and family safer. By identifying communication tools that have been effectively used in the past, the City of Beaverton can continue to make use of or augment the use of these effective sources.

## General Level of Concern

The survey results indicate that 33% of the respondents have personally experienced natural hazard within the past five years or since living in Beaverton. Of the 33% of respondents that have experienced a natural hazard; earthquake, windstorm, and flood were the most frequently cited hazards. This result reflects the February 2002 Nisqually earthquake near Seattle, the December 1995 windstorm, and flooding events in February 1996. Figure B-3 shows the most frequently experienced disasters in Beaverton.

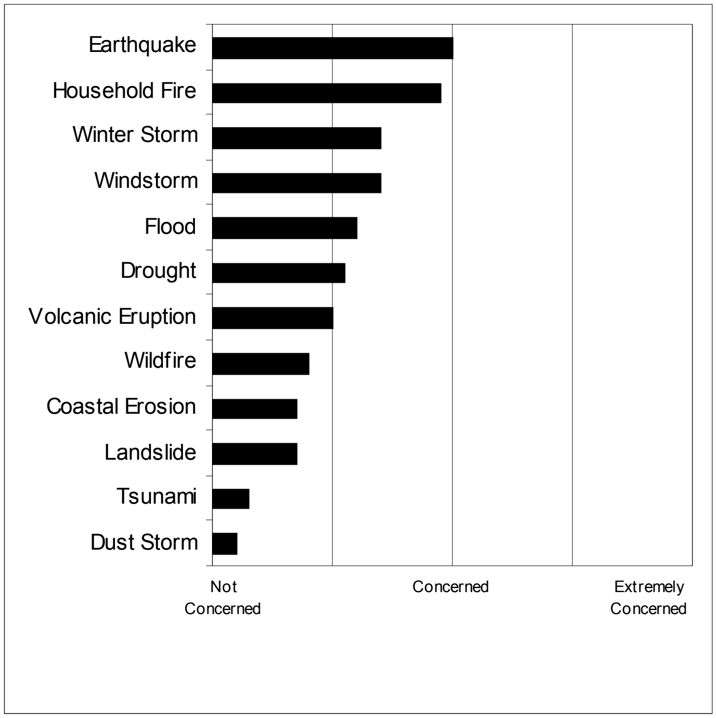
**Figure B-3. Types of disasters experienced by respondents that have experienced a disaster**




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

The survey asked respondents to rank their personal level of concern for specific natural hazards. As illustrated in Figure B-4, earthquake ranked first on the 12-item list as the hazard that Beaverton residents are the most concerned about. Despite the fact that nearly one-third of survey respondents have experienced a natural disaster, respondents had a relatively low level of concern for natural disasters.

### Figure B-4. General Level of Concern about Natural Hazards in Beaverton




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Table B-4 illustrate responses concerning the level of concern for natural hazards. Results for all hazards except for earthquake and household fire show that over 50% of respondents are only somewhat or not at all concerned about those hazards

### Table B-4. Level of Concern for Natural Hazards

| Natural Disaster | Extremely Concerned | Very Concerned | Concerned | Somewhat Concerned | Not Concerned |
|---|---|---|---|---|---|
| Drought | 4% | 9% | 20% | 29% | 38% |
| Dust Storm | 1% | 1% | 3% | 8% | 88% |
| Earthquake | 12% | 19% | 34% | 28% | 7% |
| Flood | 5% | 10% | 20% | 32% | 33% |
| Landslide / Debris Flow | 3% | 6% | 10% | 23% | 58% |
| Wildfire | 3% | 5% | 18% | 19% | 55% |
| Household Fire | 10% | 14% | 39% | 29% | 8% |
| Tsunami | 1% | 1% | 4% | 14% | 80% |
| Volcanic Eruption | 5% | 5% | 16% | 29% | 45% |
| Wind Storm | 4% | 10% | 30% | 35% | 21% |
| Coastal Erosion | 5% | 5% | 10% | 18% | 63% |
| Severe Winter Storm | 6% | 9% | 23% | 41% | 22% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

# Information Distribution

## Recent Information and Sources

Table B-5 shows when respondents most recently received information on natural disasters. Fifty-three percent of respondents indicated that they have received information regarding home and family safety at some time in the past. Of the 53% of respondents who had received information, 27% of respondents indicated that the information was received within the last six months.

### Table B-5. Respondent History of Receiving Information on Family and Home

| How Recently? | Percent of Respondents |
|---|---|
| Within the last 6 months | 27% |
| Between 1 and 2 years | 27% |
| Between 6 and 12 months | 22% |
| Between 2 and 5 years | 18% |
| 5 years or more | 6% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Of those respondents that indicated they had received information on natural hazard preparedness, over 40% said they had received it from the news media or utility companies. Eleven percent of respondents indicated that they received information from an insurance agent or company.

## Preferred Sources and Formats of Information

The creation of the Disaster Mitigation Act of 2000 has expanded the importance of educating and informing the public on natural hazard preparedness. Because of this, it is important to understand the mechanisms for information dissemination to develop and implement effective outreach and education activities. Survey findings show that 54% of respondents most trusted utility companies to provide information about home and family safety. The American Red Cross (45%) and government agencies (42%) also ranked high as trusted sources of information. Table B-6 shows the most trusted information sources for survey respondents.

**Table B-6. Most Trusted Information Sources for Household Preparedness Information**

| Source of Information | Percent of Respondents |
|---|---|
| Utility company | 54% |
| American Red Cross | 45% |
| Government agency | 42% |
| Insurance agent or company | 33% |
| University or research institution | 32% |
| News media | 29% |
| Other non-profit organization | 15% |
| Not sure | 9% |
| Other | 7% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

Table B-7 shows the preferences respondents have for 12 different methods of communication. Fifty-three percent of respondents indicated that mail as well as television news were effective methods of receiving information. Respondents also indicated that newspaper stories (44%) and fact sheets or brochures (42%) were effective methods of communication as well.

**Table B-7. The Most Effective Way for Families to Receive Information About Household Preparedness**

| Media Type | Percent of Respondents |
|---|---|
| Television News | 53% |
| Mail | 53% |
| Newspaper Stories | 44% |
| Fact Sheet/Brochure | 42% |
| Internet | 30% |
| Radio News | 29% |
| Fire Department | 29% |
| Television Ads | 13% |
| Schools | 13% |
| Public Workshop / Meeting | 13% |
| University or Research Institution | 12% |
| Books | 11% |
| Magazine | 10% |
| Radio Ads | 9% |
| Newspaper Ads | 9% |
| Outdoor Advertisements | 7% |
| Chamber of Commerce | 5% |
| Other | 4% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

# Level of Preparedness

There are many things a household can do to prepare for a natural disaster or emergency event. Basic services, such as electricity, gas, water, and telephones, may be cut off, or there may be an immediate evacuation. The Household Natural Hazard Preparedness Survey asked respondents to provide information that could help inform decision-makers of preparedness activities that are taking place at the household level in Beaverton.

## Types of Household Preparedness Activities

When asked about household preparedness activities that respondents have engaged in, the survey provided a range of choices that ranged from "Have Done" to "Unable to Do." Table B-8 summarizes the questions the respondents were asked and the types of activities that are taking place in Beaverton households.

The results show a lack of preparedness among respondent households for natural disasters. More than half of the respondents have not attended meetings or received information on emergency preparedness (59%) or been trained on CPR (65%). Only 39% had prepared a disaster supply kit and 46% had talked to their family about what to do during an emergency.

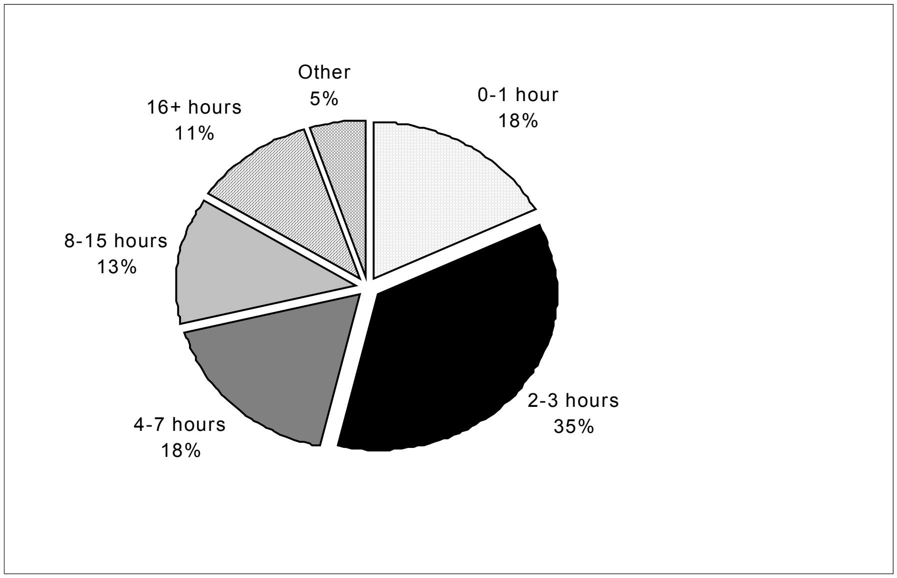
### Table B-8. Level of Household Disaster Preparedness Activities

| In your household, have you or someone in your household: | Have Done | Plan To Do | Not Done | Unable To Do |
|---|---|---|---|---|
| **A.** Attended meetings or received written information on natural disasters or emergency preparedness? | 37% | 5% | 57% | 2% |
| **B.** Talked with members in your household about what to do in case of a natural disaster or emergency? | 46% | 20% | 29% | 5% |
| **C.** Developed a "Household/Family Emergency Plan" in order to decide what everyone would do in the in event of a disaster? | 26% | 26% | 44% | 4% |
| **D.** Prepared a "Disaster Supply Kit" (Stored extra food, water, batteries, or other emergency supplies)? | 39% | 23% | 37% | 1% |
| **E.** In the last year, has anyone in your household been trained in First Aid or Cardio-Pulmonary Resuscitation (CPR)? | 30% | 5% | 63% | 2% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

To target effective programs that will better prepare residents for emergency events, the amount of time a person is willing to commit to activities is important to understand. Figure B-5 shows the number of hours, per year, that respondents would be willing to spend to make their home safer from natural hazards. The survey results show that residents are not willing to spend a lot of time (more than 8 hours) preparing for natural hazards, nearly half of the respondents would be willing to spend between two and seven hours only.

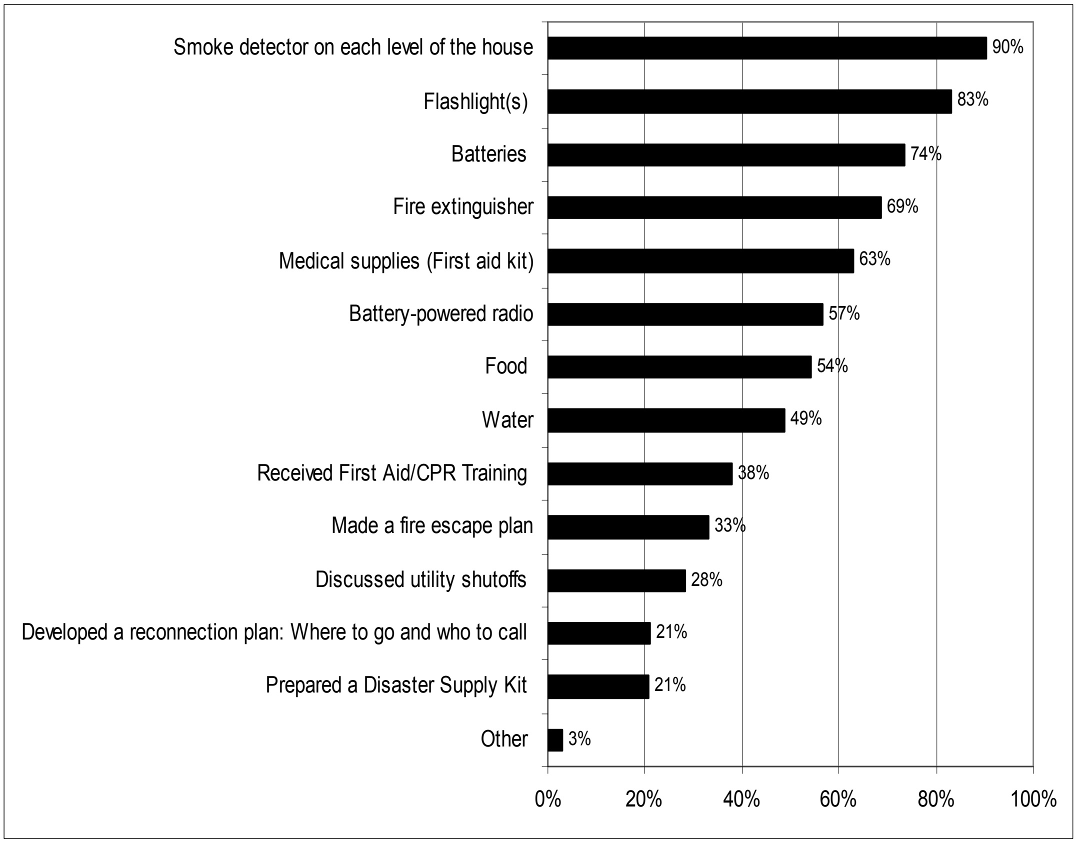
**Figure B-5. Hours Respondents are Willing to Spend Per Year on Personal and Household Natural Disaster Preparedness**




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

Figure B-6 shows the most commons steps that households have taken to prepare for natural disasters. Smoke detectors, flashlights, batteries, fire extinguishers, and medical supplies were common items stored among respondents. Household disaster preparedness steps specific to disaster response and recovery were ranked as some of the lowest items that respondents have done. For example, only 21% of respondents indicated that they had prepared a “Disaster Supply Kit,” or had established a “Reconnection Plan.”

**Figure B-6. Steps Respondents have taken to Prepare for Natural Disaster**




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

## Property and Financial Recovery

The need to have adequate provisions for financial and property recovery when natural disasters do occur is a necessary component of natural hazard preparedness. However, only 28% of the respondents indicated they have flood insurance. Approximately 59% of those who don't have flood insurance indicated the reason is because their home is not located in the floodplain. Fourteen percent felt it was not necessary. On the other hand, over 56% of respondents have earthquake insurance. The top two reasons given by those who don't have earthquake insurance were that they had never considered it (31.5%) or that it is too expensive (26.8%) (see Table B-9).

### Table B-9. Respondents' Reasons For Not Having Disaster Insurance

| Flood Insurance | Percent of Respondents | Earthquake Insurance | Percent of Respondents |
|---|---|---|---|
| Not located in floodplain | 59% | Never considered it | 32% |
| Not necessary | 14% | Too expensive | 27% |
| Never considered it | 10% | Don't know about it | 14% |
| Too expensive | 7% | Not necessary | 9% |
| Don't know about it | 5% | Deductible too high | 8% |
| Other | 3% | Not available | 6% |
| Deductible too high | 2% | Other | 4% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

# Risk Reduction Activities

This section provides information on the long-term risk reduction activities Beaverton residents have already taken or are willing to take. This section also explores how much respondents are willing to spend in order to reduce risks, and the types of incentives that would motivate respondents to take risk reduction steps.

## Home and Life Safety

Almost 63% of the respondents did not consider the possible occurrence of a natural hazard when they bought or moved into their current homes. Forty-two percent of the respondents indicated they would be willing to spend more money on a home that had disaster-resistant features, while almost 43% said they did not know whether or not they would be willing to.

Seventy-two percent of respondents indicated they are willing to make their home more resistant to natural disasters. Table B-10 illustrates how much respondents are willing to spend to better protect their homes from natural disasters.

### Table B-10. Amount Respondents Are Willing to Spend

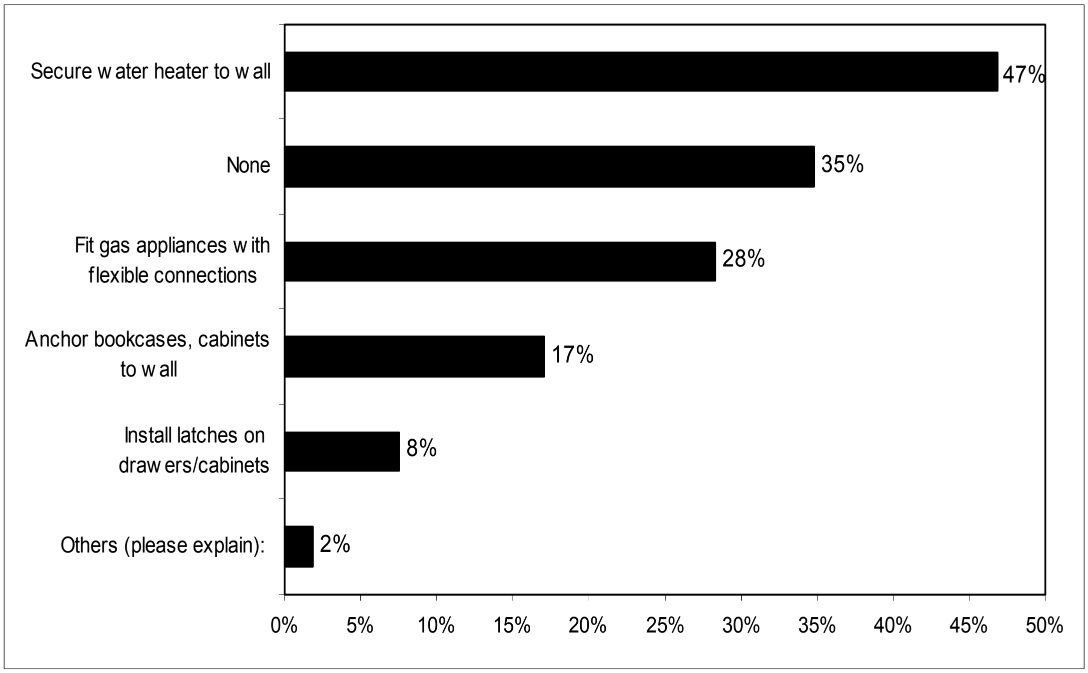
| Amount | Percent of Respondents |
|---|---|
| Less than $100 | 5% |
| $100 - $499 | 16% |
| $500 - $999 | 11% |
| $1000 - $2499 | 12% |
| $2500 - $4999 | 3% |
| $5000 and above | 4% |
| Nothing | 2% |
| Don't know | 34% |
| Other, please explain | 3% |
| What ever it takes | 10% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

## Nonstructural and Structural Home Modifications

While 34.8% of respondents said they have not completed any nonstructural modifications in their homes to prepare for earthquakes, Figure B-7 shows that some respondents have taken such steps as securing water heaters to the wall and fitting gas appliances with flexible connectors.

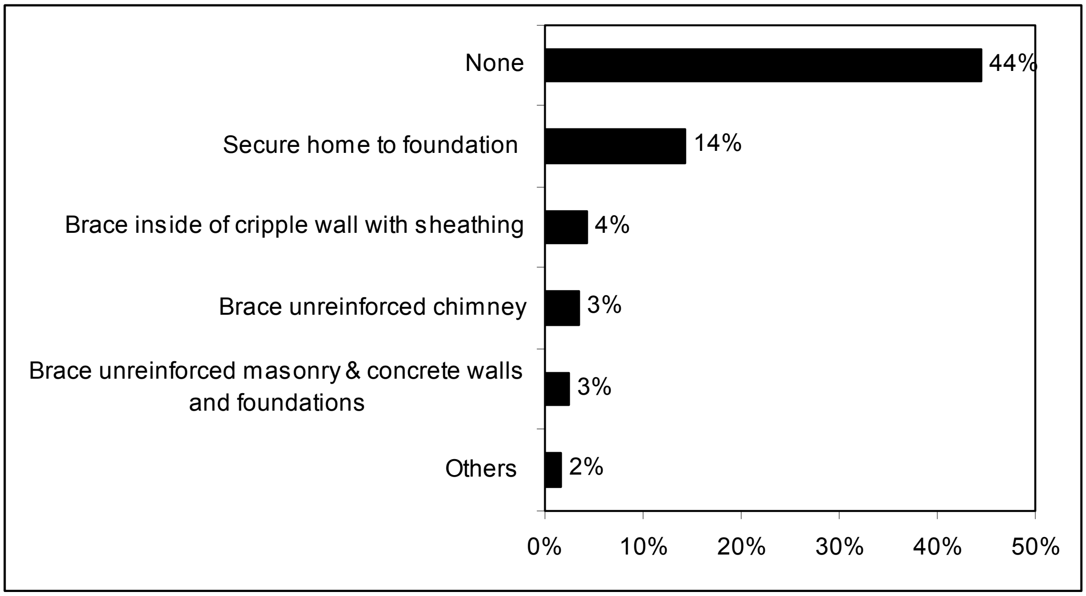
### Figure B-7. Nonstructural Modifications




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

Respondents reported making some structural modifications to make their homes more resistant to earthquakes. However, approximately 45% of the respondents have not completed any structural modifications. Figure B-8 indicates that the most common step taken is securing the home to the foundation.

**Figure B-8. Structural Modifications**

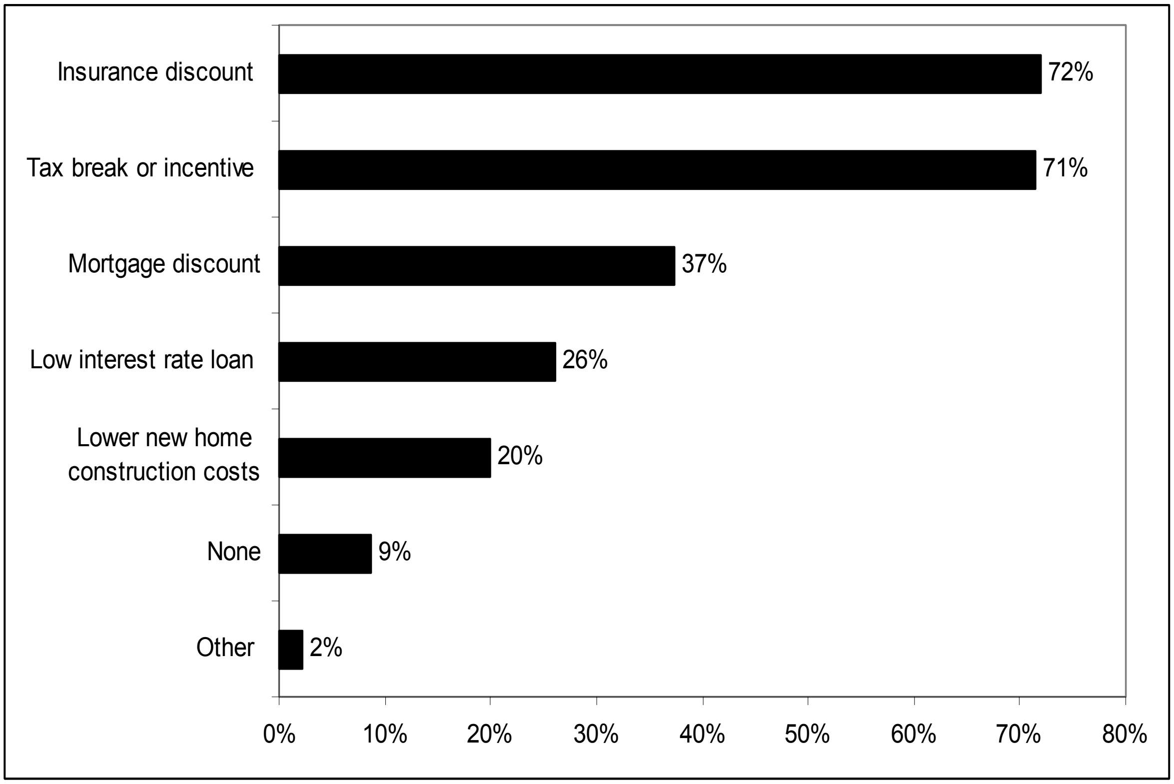



Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

## Incentives

Approximately 72% of the respondents indicated that insurance discounts would motivate them to take additional steps to better protect their homes from natural disasters. Seventy-one percent also indicated that tax breaks or incentives would be a motivator (See Figure B-9).

**Figure B-9. Incentives for Protecting Homes**

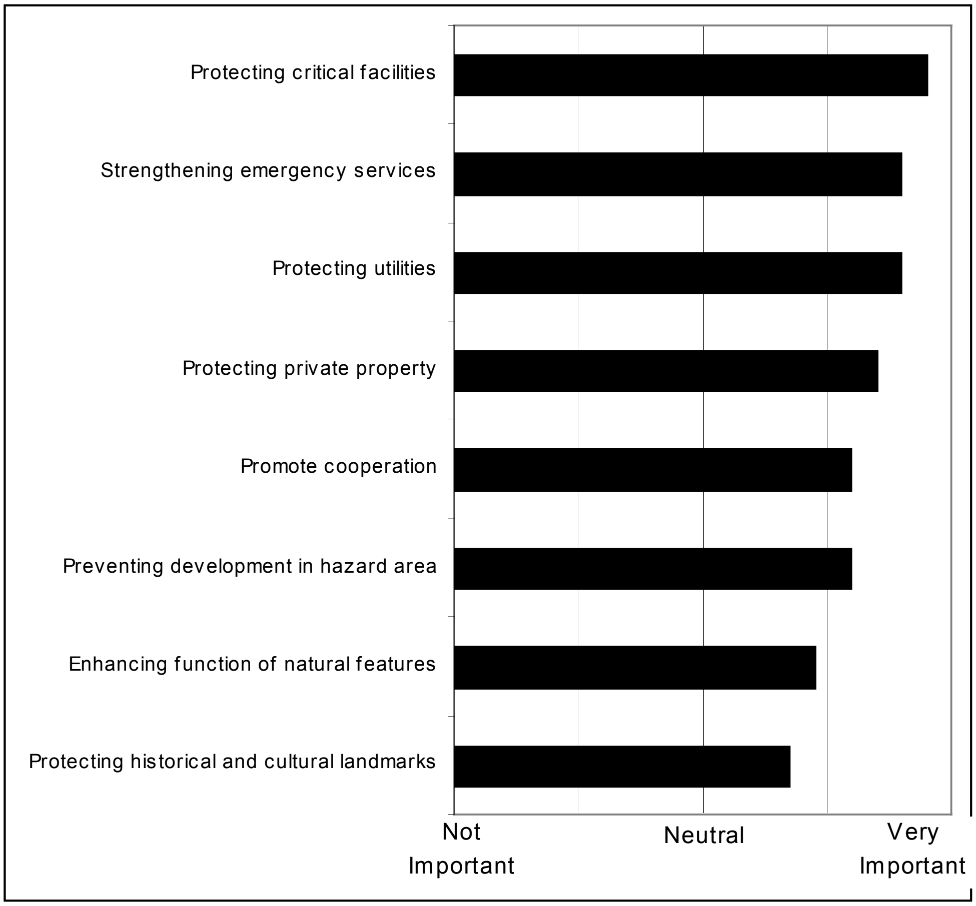



Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

# Community-wide planning goals and implementation strategies

In order to assist those preparing the City of Beaverton in developing its natural hazard mitigation plan, three questions were added to those asked in the statewide survey in 2002. These questions could help Beaverton determine citizens' priorities for planning for natural hazards and what types of strategies to reduce the communities' risk the citizens will support. Figure B-10 illustrates generally how important respondents feel each goal statement is.

**Figure B-10. General level of importance for goal statements**




Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

As shown in Table B-11, approximately 98% of respondents indicated that it is very important or somewhat important for the community to protect critical facilities (B.). About 92% indicated that it is very important or somewhat important to protect and reduce damage to utilities (G.) and 91% indicated that it is very important or somewhat important to strengthen emergency services (H.).

### Table B-11. Goal Prioritization

| Statements | Very Important | Somewhat Important | Neutral | Not Very Important | Not Important |
|---|---|---|---|---|---|
| **A.** Protecting private property | 58% | 30% | 8% | 3% | 1% |
| **B**. Protecting critical facilities (e.g. transportation networks, hospitals, fire stations) | 86% | 12% | 2% | 1% | 0% |
| **C.** Preventing development in hazard areas | 45% | 35% | 17% | 2% | 1% |
| **D.** Enhancing the function of natural features (e.g. streams, wetlands) | 35% | 33% | 25% | 6% | 2% |
| **E.** Protecting historical and cultural landmarks | 23% | 38% | 28% | 9% | 3% |
| **F.** Promoting cooperation among public agencies, citizens, non-profit organizations, and businesses | 42% | 38% | 16% | 2% | 2% |
| **G**. Protecting and reducing damage to utilities | 65% | 27% | 7% | 1% | 0% |
| **H**. Strengthening emergency services (e.g.- police, fire, ambulance) | 68% | 23% | 8% | 1% | 1% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

There are a number of activities a community can undertake to reduce the risk from natural hazards. These activities can be both regulatory and non-regulatory. Table B-12 shows respondents' general level of agreement regarding the community-wide strategies included in the survey.

Table B-12 illustrates that 85% of the respondents strongly agree or agree that they support improving the disaster preparedness of local schools (J.). Approximately 78% strongly agree or agree that support steps to safeguard the local economy (I.), while 75% said they strongly agree or agree that they support policies to prohibit development in areas subject to natural hazards (D.).

### Table B-12. General level of agreement regarding community-wide strategies

| Community-wide Strategies | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Not Sure |
|---|---|---|---|---|---|---|
| A. I support a regulatory approach to reducing risk | 15% | 38% | 24% | 13% | 5% | 6% |
| B. I support a non-regulatory approach to reducing risk | 19% | 38% | 26% | 10% | 1% | 6% |
| C. I support a mix of both regulatory and non-regulatory approaches to reducing risk | 22% | 42% | 21% | 7% | 3% | 5% |
| D. I support policies to prohibit development in areas subject to natural hazards | 32% | 43% | 18% | 4% | 2% | 2% |
| E. I support the use of tax dollars (federal and/or local) to compensate land owners for not developing in areas subject to natural hazards | 6% | 18% | 25% | 30% | 17% | 3% |
| F. I support the use of local tax dollars to reduce risks and losses from natural disasters | 7% | 51% | 27% | 9% | 4% | 2% |
| G. I support protecting historical and cultural structures | 10% | 39% | 39% | 8% | 4% | 0% |
| H. I would be willing to make my home more disaster-resistant | 13% | 59% | 23% | 1% | 1% | 3% |
| I. I support steps to safeguard the local economy following a disaster event | 16% | 62% | 19% | 2% | 1% | 1% |
| J. I support improving the disaster preparedness of local schools | 33% | 52% | 12% | 3% | 0% | -- |
| K. I support a local inventory of at-risk buildings and infrastructure. | 17% | 53% | 23% | 4% | 2% | 2% |

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

The household survey examined attitudes about hazards in the City of Beaverton and identified a number of issues that the city could use to improve community preparedness. Some issues that the majority of survey respondents, who are a majority of homeowners, included the fact that only a third of them have experienced the impacts of natural hazards. Of those that have experienced hazards the majority have experienced earthquakes – this is also the only hazard that a majority of residents are concerned about. Education regarding the impacts and preparedness of the community's hazards may be appropriate – as this survey indicates that they may be overlooked. Additional information includes that the most trusted source of information is the utility providers – this may be a good conduit for continuing outreach efforts. The most effective way that the survey respondents indicated to receive information is both television and mail – the city may want to consider coordinating outreach through these aspects. Other information that may be of benefit to the city is that the most important goals the survey respondents noted were to protect critical facilities, emergency services and utilities – efforts to protect these aspects of the community through mitigation activities may be more broadly supported by the community. Lastly, the survey respondents generally supported using local tax dollars to reduce risks and losses from natural disasters and use a mix of regulatory and non-regulatory approaches to reducing risk.

## Appendix B Endnotes

[1] Qwest develops samples by using the nth selection technique to ensure randomness.

# Appendix C
# Business Preparedness Survey

ONHW conducted a business preparedness survey in Beaverton with funding provided by the City. The survey asked Beaverton businesses to consider natural hazards; what impacts hazards have on businesses, what they have done to prepare, and what services are critical to business operations. This survey allowed businesses to become better informed on what the city is doing to reduce risks within the community and what actions it could still undertake. This helped satisfy public participation requirements while also allowing for public values to be incorporated into the planning process. Understanding how the business community views natural hazards is an important part of the natural hazard mitigation process. Businesses play an important role in the local economy; therefore, examining potential impact on businesses as well as essential business services may help to identify gaps in preparedness, and ways in which public/private coordination could be improved within the City.

## Methods

ONHW adapted this survey from one previously implemented in Jackson County, Oregon as part of the development of a natural hazard Mitigation Plan. The survey went through multiple review processes and was field-tested for readability and content. Input from the field test and the project steering committee refined the survey further before its distribution. The survey addressed the following topics:

- General information and background;
- Natural hazard business impacts;
- Preparedness activities;
- Essential business services; and
- Essential business mitigation activities.

ONHW distributed 1,500 surveys by mail to randomly selected businesses located in Beaverton. The sample list was provided by the City of Beaverton's Finance Department. ONHW received 363 valid responses, which yielded a 24% response rate.

A total of three mailings were made to survey recipients during the months of January and February 2003. The first mailing included a cover letter, a survey, and a business reply envelope. Ten days later, a reminder postcard was sent to all businesses asking them to return the survey if they had not yet done so and thanking them if they already had. Three weeks after the initial survey mailing, a second mailing was sent to those who had not yet responded to the survey. This particular methodology was chosen to help maximize responses.

## Limitations of Sampling Methodology

This survey identifies key issues about how businesses perceive their risk from natural hazards in Beaverton. Moreover, it is a snapshot of perceptions at a single point in time. As such, survey responses may reflect external issues, such as terrorism threats or recent occurrences of natural hazards. The survey was not intended to be representative of the perceptions of all Beaverton businesses.

Another limitation of the study's methodology is potential non-response bias from the mailed survey. If one were to assume that the sample was perfectly random and that there was no response bias, then the survey would have a margin of error of ±5% at the 95% confidence level. This means that if the survey were conducted 100 times, the results would end up within ±5% of those presented in this report.

Non-response bias is an issue in all surveys, but is particularly important in mailed surveys due to response rates. The Business Preparedness Questionnaire had a 24% response rate. The question that we cannot answer with 100% confidence is whether those 24% are representative of the entire population, or of some portion of the population that holds a different set of opinions.

## Organization of Survey Findings

The report is organized into the following sections:

***General Information and Background:*** This section describes the characteristics of survey respondents and compares the survey results with selected business characteristics outlined in the Economic Development Strategic Plan.

***Natural Hazard Business Impacts:*** This section creates a profile of survey respondents and identifies:

- The level of impact of hazards on the business;
- The importance of business services in operations;
- The length of time in which the business would be impacted by a disaster;
- The transportation modes on which the business depends; and
- The methods in which businesses prefer to receive natural hazard mitigation information in the future.

***Preparedness Activities:*** This section provides an overview of businesses' natural hazard preparedness activities in Beaverton.

***Essential Business Services:*** This section provides information on how important certain business related services are to operations. The services include: electrical power, telecommunications, water, sewage disposal, and natural gas.

***Essential Business Mitigation Activities:*** This section provides an overview of how useful certain mitigation activities are to business operations. The mitigation activities in this question are related to: facility and road access, utilities, businesses helping businesses, training and public outreach, risk reduction incentives, and community-wide activities.

***Survey Results:*** Included at the end of this appendix are the results from the Business Preparedness Survey. A listing of written general comments is also included.

# General Information and Background

General information and background questions provide a statistical overview of the characteristics of respondents. This section of the survey asked respondents about the type of business, number of years the business has been in operation, type of structure the business occupies, the number of employees, and average commute times. Where appropriate, the results are compared with the City's Economic Development Strategic Plan to illustrate differences in the sample population and the overall City business population.

## Business Characteristics

In 1998, the City of Beaverton had approximately 4,500 firms with covered employees for a total of 63,700 workers. This survey represents 363 of those employers and 3,626 current jobs. The first five questions of the survey requested general business information: years of operation, type of business, ownership status, and employees – how many and average commute time to work.

Key findings from the City of Beaverton respondents related to business age, business type, and ownership include:

- 45% of business owners have been in operation for 1 to 10 years; 38% have been in operation for 11 to 25 years; and 3% have been in operation between 51 and 100 years.
- 76% owned/operated individual firms, while 8% owned/operated a chain of businesses.
- 61% lease the building their business occupies, while 27% own the building their business occupies.

Key findings from the City of Beaverton respondents related to business size and distance from business location and employees:

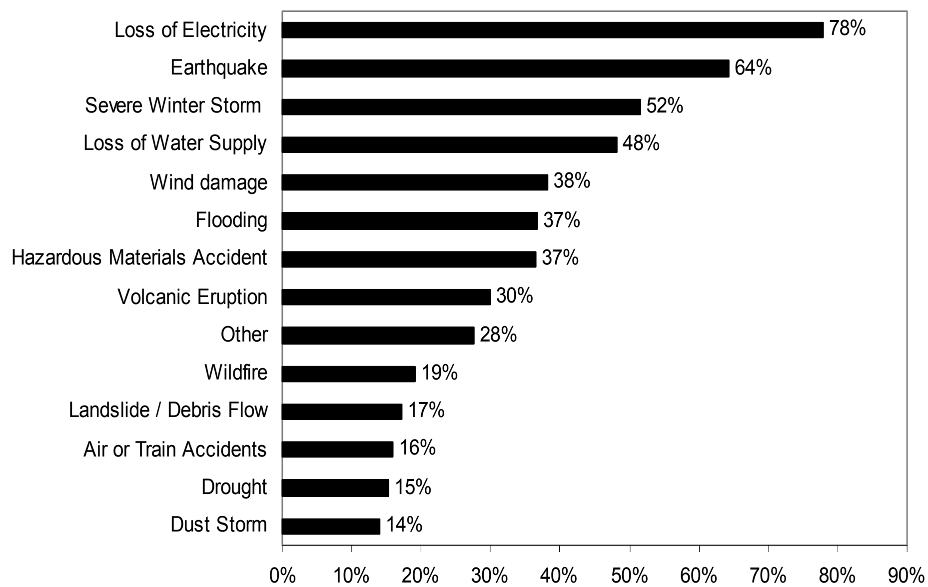
- 72% of respondents had less than 20 employees; only 11% had over 20 employees. According to the City of Beaverton Economic Development Strategic Plan, 88% of businesses in Beaverton have less than 20 employees; while 12% have more than 20 employees.
- 37% report that their employees typically commute between 15 and 29 minutes, while 20% indicated that the average employee commute was between 5 and 14 minutes.

# Natural Hazard Business Impacts

## Impact on Business

The survey asked respondents to indicate how severe an impact 13 different natural hazards would inflict on their businesses. Figure C-1 illustrates the hazards with the greatest impact – percentages are reflective of combining the serious and moderate impact responses. Respondents indicated that loss of electricity (78%), earthquake (64%), and severe winter storm (52%) had the potential to cause both serious and moderate impact. Air or train accident, drought, and dust storm were ranked the lowest with combined ratings of serious and moderate at 16%, 15%, and 14% respectively.

**Figure C-1. Severity of impact for natural disasters on business operations**




Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

Table C-1 lists the potential hazard events and indicates the potential levels of impact the respondents identified that each hazard event might have on their business.

### Table C-1. Potential Impacts

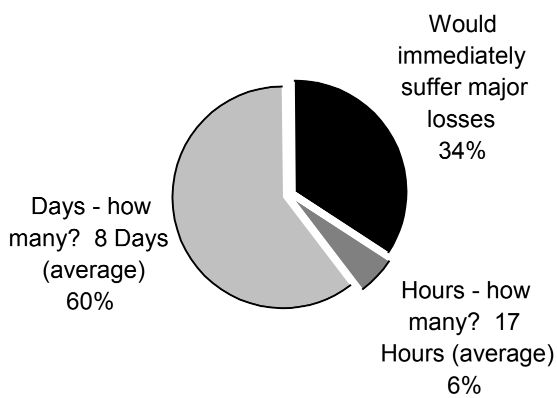
| Hazard | Serious | Moderate | Slight | None | No need to address now |
|---|---|---|---|---|---|
| Loss of Electricity | 53.0% | 24.9% | 12.8% | 4.9% | 4.3% |
| Earthquake | 33.3% | 31.0% | 22.5% | 7.3% | 5.8% |
| Loss of Water Supply | 26.2% | 21.9% | 30.9% | 14.9% | 6.1% |
| Other | 25.0% | 2.5% | 5.0% | 32.5% | 35.0% |
| Severe Winter Storm | 19.1% | 32.4% | 30.0% | 13.2% | 5.3% |
| Hazardous Materials Accident | 18.1% | 18.4% | 27.0% | 26.4% | 10.1% |
| Flooding | 17.6% | 19.1% | 27.1% | 29.1% | 7.1% |
| Volcanic Eruption | 17.4% | 12.6% | 28.1% | 28.1% | 13.8% |
| Wind damage | 12.0% | 26.3% | 40.9% | 14.9% | 5.8% |
| Wildfire | 11.0% | 8.1% | 26.6% | 41.2% | 13.1% |
| Landslide / Debris Flow | 8.3% | 8.9% | 26.8% | 46.1% | 9.8% |
| Air or Train Accidents | 7.4% | 8.6% | 26.8% | 44.8% | 12.4% |
| Drought | 5.4% | 9.9% | 24.0% | 50.5% | 10.2% |
| Dust Storm | 5.3% | 8.8% | 28.3% | 44.2% | 13.3% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

## Business Closure

The survey asked respondents to indicate how long they could afford to close their business without suffering major financial loss. The majority of respondents (60%) indicated that they could be closed for a period of days with eight days being the average number of days they could afford to be closed. Thirty-four percent of respondents indicated that they would immediately suffer major losses, while 6% indicated that they would suffer losses within hours. The average number of hours before significant losses was 17 hours. Figure C-2 illustrates the percentage of respondents who would suffer loss immediately, within hours, or within days

### Figure C-2. Length of time before suffering major financial losses

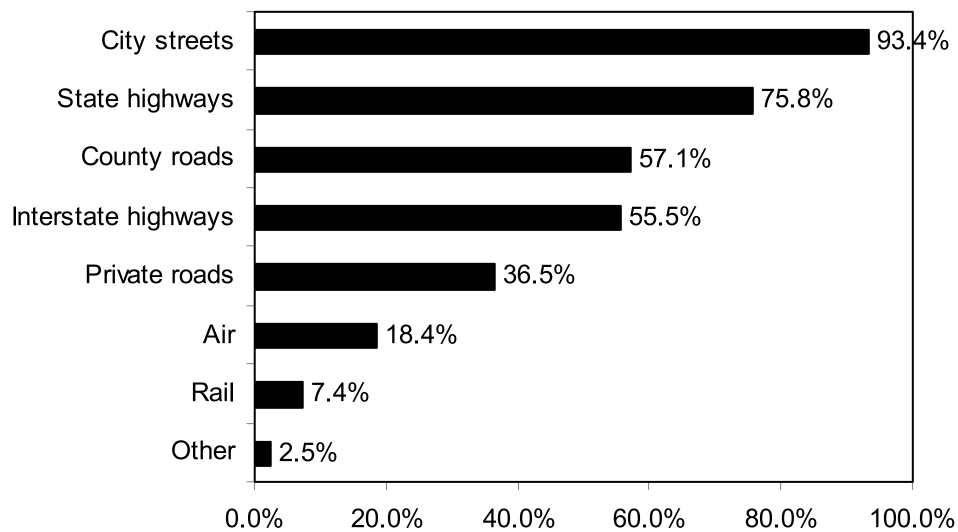



Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

## Transportation Systems

Respondents were asked to indicate all of the segments of the transportation system their business relies on. The most used means of transportation included: city streets (93%), state highways (76%), and county roads (57%). Figure C-3 illustrates the percentage of respondents whose business relies on the segments of the transportation system.

### Figure C-3. Transportation System

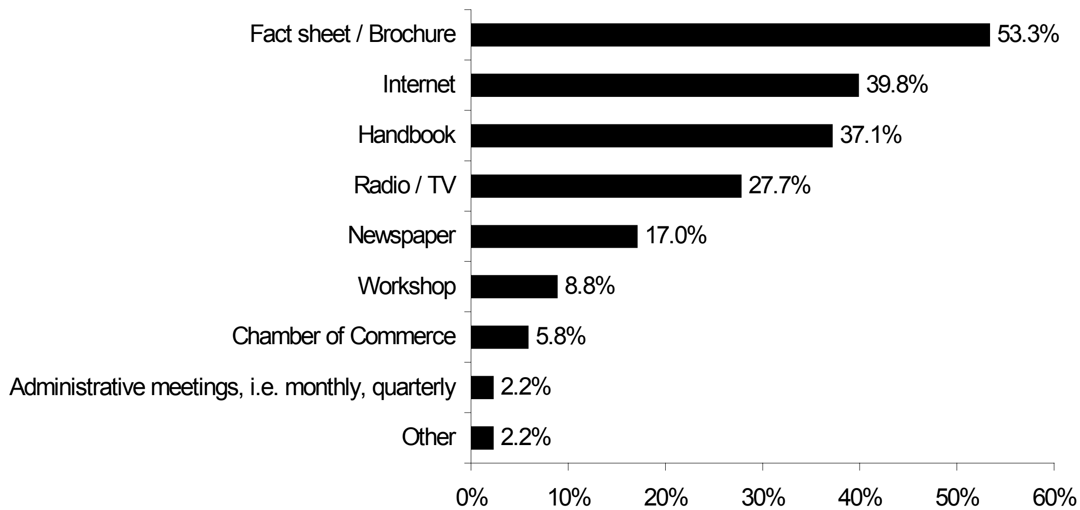



Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

## Effective Information Formats

The survey also asked respondents to indicate their preferred format for receiving information about mitigation and preparedness activities. Just over half the respondents, 53% indicated that fact sheets or brochures were effective means of receiving information. The Internet (40%) and handbooks (37%) were the second and third selected formats. “Other” responses included mailings and newsletters. Figure C-4 illustrates the respondent’s preferred formats for receiving information.

**Figure C-4. Effective Information Formats [eliminate white space; % axis title]**




Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

# Preparedness Activities

There are many things a business can do to prepare for a natural disaster or emergency event. Basic services, such as electricity, gas, water, and telephones, may be cut off, or there may be an immediate evacuation. The Business Preparedness Survey asked respondents to provide information that could help inform decision-makers of preparedness activities that are taking place in the business community in Beaverton.

## Natural Hazard Event Planning

The survey asked respondents to indicate whether they have done, plan to do, have not done, or are unable to do certain all-hazard preparedness activities. The activity that most businesses have already done was to purchase insurance (54%). Only 10% of respondents have conducted disaster drills or exercises to prepare their employees for a natural hazard event. Table C-2 presents the respondents' responses to this question.

## Table C-2. Natural Hazard Event Preparedness Activities

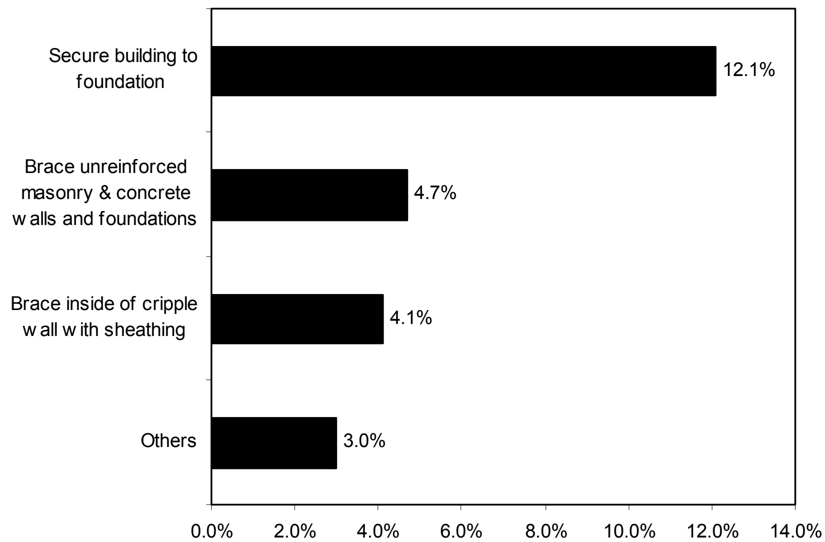
| At your business, have you or your employees: | Have Done | Plan To Do | Not Done | Unable To Do | N/A |
|---|---|---|---|---|---|
| **A.** Talked with employees about what to do in case of a natural disaster? | 27.9% | 12.8% | 39.2% | 0.3% | 19.8% |
| **B.** Developed a plan to notify employees? | 29.1% | 12.6% | 34.4% | 0.9% | 22.9% |
| **C.** Purchased insurance for your business? (e.g. flood, earthquake) | 54.3% | 2.7% | 27.6% | 3.0% | 12.5% |
| **D.** Purchased business interruption insurance? | 30.1% | 5.7% | 45.1% | 3.3% | 15.8% |
| **E.** Stored extra fuel, batteries or other emergency supplies? | 30.3% | 10.2% | 45.8% | 2.9% | 10.8% |
| **F.** Developed a business emergency response plan? | 20.2% | 15.0% | 50.7% | 0.3% | 13.8% |
| **G.** Developed a business emergency recovery plan? | 14.4% | 14.4% | 58.7% | 0.6% | 12.0% |
| **H.** Conducted any disaster drills or exercises? | 9.6% | 9.0% | 64.5% | -- | 16.9% |
| **I.** Made arrangements to move the business to another location in case of disaster damage? | 10.6% | 5.6% | 51.3% | 14.4% | 18.2% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

## Structural and Non-structural Modifications

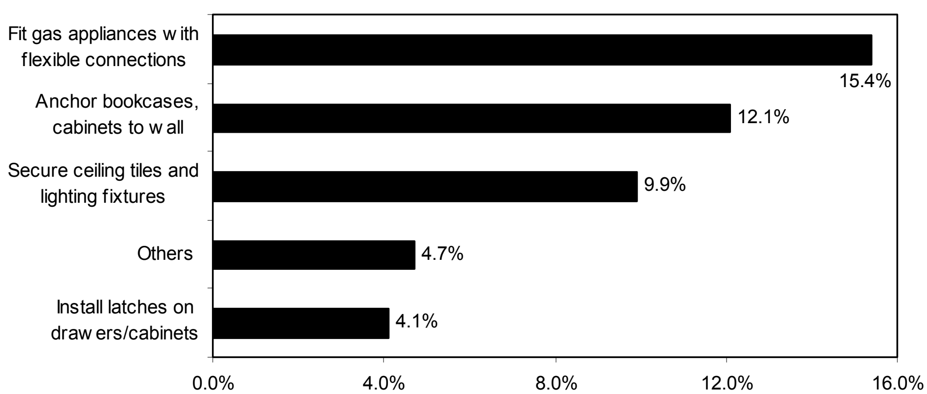
Structural modifications strengthen a structure so it can better withstand the force of an earthquake, while non-structural modifications reduce the potential of loss of building contents.[1] Survey respondents were asked to indicate which structural and non-structural modifications they had made at their business. Twelve percent of respondents indicated that they had secured the building to its foundation. Overall, very few respondents had implemented structural mitigation activities at their businesses. Figures C-5 and C-6 illustrate the structural and non-structural modifications that respondents have undertaken.

**Figure C-5. Structural Modifications**




Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

**Figure C-6. Non-structural Modifications**




Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

# Essential Business Services

The survey specifically addressed the importance lifeline services for business operations (See Table C-3). Respondents were asked to rate the level of importance of each critical service for business operations. Five types of service were covered including: electrical power, telecommunications, water, sewage disposal, and natural gas. For each service category, an "other" category was provided to capture answers that were not listed in the questionnaire.

Table C-3 illustrates the level of importance of certain services for continuity of business operations. Survey respondents indicated that electricity (71%) and phone/internet (58%) were the most important critical services to their businesses. Respondents indicated that natural gas was the least important of the services listed.

### Table C-3. Essential Business Services

| Service | Critical | Very Important | Important | Not Very Important | Not Important At All |
|---|---|---|---|---|---|
| Electricity | 71.3% | 21.1% | 5.3% | 2.0% | 0.3% |
| Phone/Internet | 57.5% | 24.1% | 13.3% | 2.8% | 2.3% |
| Transportation, e.g. roads, rail | 30.4% | 27.5% | 26.0% | 11.1% | 5.0% |
| Water | 29.5% | 25.5% | 22.4% | 19.8% | 2.8% |
| Sewer and waste water treatment | 23.1% | 25.9% | 30.5% | 15.0% | 5.5% |
| Postal | 19.6% | 27.7% | 32.3% | 16.7% | 3.7% |
| Natural gas | 18.7% | 21.3% | 26.1% | 15.2% | 18.7% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

#### *Electrical Power*

The survey asked respondents how important electrical services is for four basic business operations: computers/cash registers; machinery; lights/office; and heating/ventilation/air conditioning.

- 46% of survey respondents considered electricity critical to power computers and cash registers.
- 43% indicated that electricity was critical for powering lights and the office.
- 19% of respondents noted that electricity to power machinery was not very important.

The "other" responses for this category indicated that electricity was also important for refrigeration and dental equipment.

#### *Telecommunications*

Telecommunications in the form of telephones, fax machines, computer modems, and credit card machines are important to many businesses.

- 82% of respondents indicated that phones were either critical or very important for telecommunication.
- 41% indicated that computers and modems were critical to telecommunications as well.

The "other" responses for this category indicated that telecommunications was also important for cell phones.

#### *Water*

Water for drinking, cooking, bathroom and sanitary use, industrial use, and HVAC systems, is considered a critical service for many survey respondents.

- 58% of respondents do not use water for industrial use.
- 67% indicated that water for drinking or cooking was important, very important or critical.
- 89% of respondents indicated that water for bathrooms and sanitary use was important, very important or critical.

The "other responses for this category indicated that water was also important for dental use and making ice.

### *Sewage Disposal*

For the purpose of this survey, two uses of sewage disposal were identified: bathrooms – sanitary and industrial wastewater.

- 33% of respondents considered bathroom use and sanitary sewers as critical to business operations.
- 62% indicated that sewage disposal was not used for industrial wastewater purposes.

No "other" responses were provided for this category.

### *Natural Gas*

Natural gas is used in industrial processes and HVAC systems for many businesses.

- Nearly 70% of respondents indicated that they did not use natural gas for industrial processes.
- 62% of respondents considered natural gas for heating, ventilation, or air conditioning either important, very important, or critical.

The "other" responses for this category indicated that natural gas was also important in cooking, powering water heaters and powering generators.

## Essential Business Mitigation Activities

The survey asked respondents to identify how important various mitigation activities would be to their business and to gauge their level of preparedness.

Survey respondents evaluated the potential importance of specific mitigation activities for their business by rating the activities as very useful, somewhat useful, not useful, or already addressed. Five categories of mitigation activities were listed in the questionnaire including: facility and road access; data and equipment; utilities; businesses helping businesses; training and public outreach; risk reduction incentives, and community wide activities.

### *Facility and Road Access*

Table C-4 indicates how respondents rated potential activities, and also shows whether a particular mitigation activity is considered not useful ("very" and "somewhat" useful) or has already been addressed. Both activities (Activities 1: Road access issues and debris removal and 2: Alternate route availability) were considered very useful by between 57% and 46% of survey respondents. The activities had only been addressed by approximately 2.5% of the respondents.

**Table C-4. Respondent Rating of Facility and Road Access Mitigation Activities** (Numbered as Noted on Survey)

| Activity | | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|---|
| **1** | Road access issues and debris removal | 56.8% | 30.9% | 10.0% | 2.4% |
| **2** | Alternate route availability | 45.8% | 40.7% | 10.8% | 2.7% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

### *Data and Equipment*

Table C-5 shows which data and equipment related mitigation activities respondents considered to be either useful ("very" and "somewhat" useful) or not useful. Half of the respondents considered protecting data and equipment (Activity 3) a very useful mitigation activity, while 40% indicated that the retrieval of critical data (Activity 4) was very useful.

**Table C-5. Respondent Ratings of Data and Equipment Mitigation Activities** (Numbered as Noted on Survey)

| Activity | | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|---|
| **3** | Data and equipment protection | 50.0% | 28.5% | 16.4% | 5.2% |
| **4** | Retrieval of critical data from storage | 40.1% | 31.8% | 22.3% | 5.8% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

### *Utilities*

Table C-6 shows which utility-related mitigation activities survey respondents considered to be very useful and somewhat useful. Back-up power sources (Activity 6) were considered the most potentially useful activity at 91%, followed by forming single points of contact to report utility failure (Activity 7) (88%) and making information "one phone call away" for businesses (Activity 5) (87%). A very small percentage, between two and five percent had already addressed these issues.

## TableC-6. Respondent Ratings of Utility Mitigation Activities

| Activity | | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|---|
| **5** | Making information “one phone call away” for businesses | 45.0% | 41.5% | 11.0% | 2.5% |
| **6** | Back-up sources of power | 56.5% | 34.8% | 6.6% | 2.1% |
| **7** | Single point of contact for reporting any utility failures | 49.1% | 39.0% | 10.4% | 1.5% |
| **8** | Alternate communications | 38.2% | 46.8% | 11.4% | 3.7% |
| **9** | Alternate shipping/transportation | 16.4% | 42.3% | 36.3% | 4.7% |
| **10** | Wastewater treatment | 19.6% | 41.4% | 33.6% | 4.7% |
| **11** | Water supply | 41.7% | 43.5% | 10.5% | 3.6% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

### *Businesses Helping Businesses*

Businesses helping businesses refers to reaching out and forming partnerships before a disaster strikes and mutually increasing business resilience after a disaster. Table C-7 shows that over 76% of respondents considered developing a central contact office to quickly disseminate information as potentially beneficial (Activity 18). Approximately half (51%) of respondents indicated that mentoring programs between more and less prepared businesses (Activity 14) was useful and 50% indicated that availability of food vendors to supply large facilities, which could in turn host smaller businesses (Activity 16) was not a useful mitigation activity. Only about two percent of respondents have implemented any of the activities listed in this category.

### Table C-7. Respondent Ratings of Businesses Helping Businesses Mitigation Activities

| Activity | | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|---|
| 12 | Share resources among businesses in an emergency situation | 32.8% | 42.1% | 22.6% | 2.2% |
| 13 | Work with "like" businesses on mitigation projects | 19.5% | 41.2% | 36.5% | 2.5% |
| 14 | Mentoring program between more and less prepared businesses | 11.2% | 39.4% | 46.5% | 2.6% |
| 15 | Mutual aid networks for emergency shelter and food | 22.8% | 44.6% | 30.1% | 2.2% |
| 16 | Food vendors able to supply large facilities, which could in turn host smaller businesses | 13.1% | 33.3% | 50.3% | 2.9% |
| 17 | Developing a plan for direct notification to vulnerable businesses | 18.8% | 44.4% | 33.5% | 2.9% |
| 18 | Developing a central contact office to quickly disseminate information | 34.2% | 42.0% | 21.0% | 2.5% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

## *Training and Public Outreach*

Table C-8 indicates that planning and publicizing alternate commute routes was considered to be either very or somewhat useful, at 75%. The activity with the highest percentage of not useful responses was alternate schools/day care sites so employees can leave home for work. Less than two percent of respondents had implemented any of the training and public outreach mitigation activities.

### Table C-8. Respondent Ratings of Training and Public Outreach Mitigation Activities

| Activity | | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|---|
| 19 | Need for communication with City of Beaverton Emergency Management Office | 27.1% | 46.7% | 24.6% | 1.2% |
| 20 | Planning and publicizing alternate commute routes | 31.6% | 43.8% | 23.1% | 1.3% |
| 21 | Alternate schools/day care sites so employees can leave home for work | 13.1% | 38.2% | 47.5% | 1.0% |
| 22 | Help employees make plans to protect themselves and their home | 19.2% | 51.7% | 27.1% | 1.6% |
| 23 | Develop a website for business & community to report damages and recovery after a disaster | 25.3% | 46.2% | 27.5% | 0.6% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

### *Risk Reduction Incentives*

Three quarters of respondents, 75%, indicated that information emphasizing disaster preparedness and recovery as part of business operations would be either very or somewhat useful. Seventy-four percent of respondents considered expediting the permit process for mitigation projects to be useful, and 69% considered loans and grants for structural mitigation useful mitigation activities. Very few respondents had implemented any of the mitigation activities in this category.

**Table C-9. Respondent Ratings of Risk Reduction Incentives**

| Activity | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|
| **24** Loans and grants for structural retrofits and other disaster preparedness measures | 29.3% | 39.5% | 29.9% | 1.3% |
| **25**. Expedite permit process for mitigation projects | 37.3% | 36.4% | 25.3% | 1.0% |
| **26** Information that emphasizes disaster preparedness and recovery as part of business operations | 27.3% | 47.4% | 24.0% | 1.3% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

### *Community-wide Activities*

Respondents were asked to rate the usefulness of certain community-wide mitigation activities as well as activities that they could implement themselves. Respondents considered the most useful activity (either very or somewhat useful) to be cooperation among agencies, citizens, non-profit organizations, business and industry (80%). Fifty-nine percent of respondents indicated that the use of local tax dollars to reduce risk was either very or somewhat beneficial. The use of federal and/or local tax dollars to compensate land owners for not developing in areas subject of natural hazards was considered by 47% of respondents to be not useful.

### Table C-10. Respondent Ratings of Community-wide Mitigation Activities

| Activity | Very Useful | Somewhat Useful | Not Useful | Already Addressed |
|---|---|---|---|---|
| **27** Regulatory approaches for reducing risk (e.g. policies limiting development in hazard areas) | 23.3% | 46.0% | 29.4% | 1.0% |
| **28** Non-regulatory approaches to reducing risk (e.g. site specific mitigation activities) | 14.3% | 55.5% | 28.6% | 1.3% |
| **29** Mix of regulatory and non-regulatory approaches to reducing risk | 17.3% | 51.5% | 30.2% | 0.7% |
| **30** Use of federal and/or local tax dollars to compensate land owners for not developing in areas subject to natural hazards | 16.4% | 35.5% | 46.5% | 1.3% |
| **31** Use of local tax dollars to reduce risk | 13.3% | 45.5% | 39.5% | 1.3% |
| **32** Cooperation among agencies, citizens, non-profit organizations, business and industry | 32.1% | 47.5% | 19.0% | 1.0% |
| **33** Inventories of at-risk buildings and infrastructure | 23.1% | 42.9% | 32.7% | 1.0% |

Source: ONHW/CPW, Beaverton Business Perception Survey, (January 2003)

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## Appendix C Endnotes

[1] Institute for Business and Home Safety.1999. Is Your Home Protected From Earthquake Disaster?

# Appendix D
# Focus Group Results

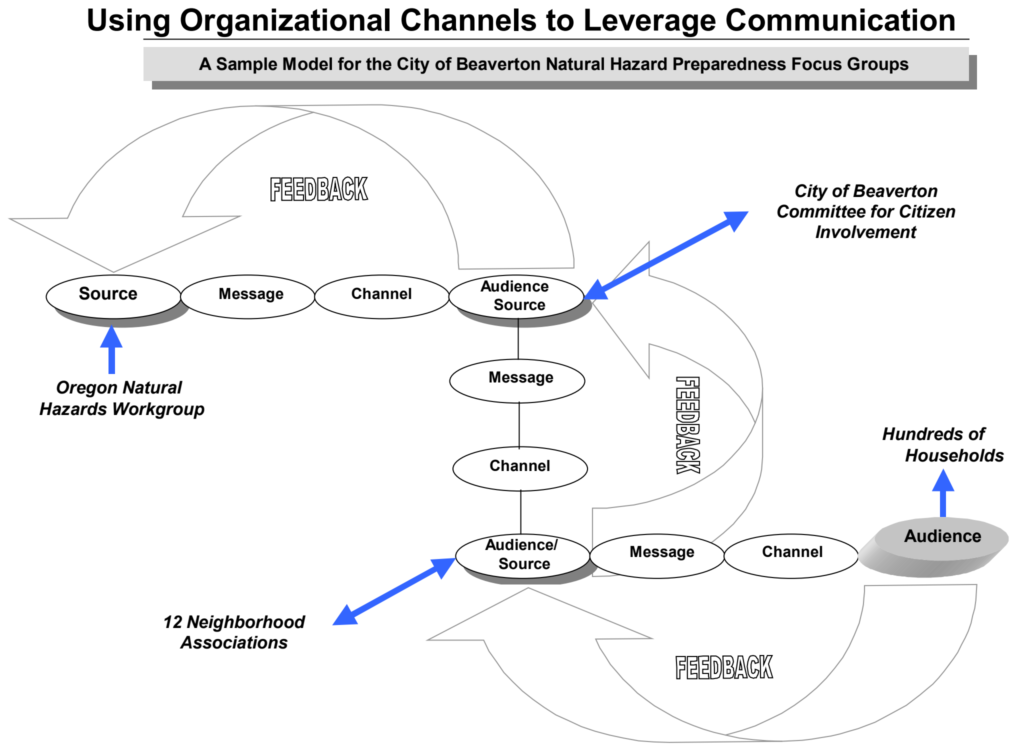
This appendix reports the results of three citizen focus groups on natural hazard risk reduction that were held in conjunction with the development of a Natural Hazard Mitigation Plan for the City of Beaverton. The focus groups were conducted during the process of making the plan in order to gain an understanding of resident's levels of preparedness, gather ideas on risk reduction strategies the City could take, and to prioritize plan goals and implementation strategies.

## Methodology

ONHW reviewed the household preparedness survey instrument along with preliminary results in order to determine what kind of information would be gathered through the focus group process. Several key themes came out of the survey including: household risk perception, household preparedness, willingness to reduce risk, and citizen priorities for community-level risk reduction. These themes were explored further in the focus group process. The household survey provided a snapshot in time on these natural hazard mitigation themes, but the focus group process allowed more qualitative data to be collected. A total of three focus group sessions were held in Beaverton between April 14 and April 21, 2003.

Two recruitment strategies were implemented in this process and included self-selection through the household survey and invitations through ONHW's Leveraged Communication Strategy (LCS). Included in the household survey mailing was an interest form that respondents could fill out indicating their interest in participating in one of the focus groups. Those who returned the interest form were contacted via letter and telephone and asked to participate. The LCS used existing communication channels to share information with households about the focus groups. Figure D-1 illustrates how the LCS works. In this case, ONHW gave information about the focus groups to the City of Beaverton's Committee for Citizen Involvement who then passed it along to 12 different neighborhood association committees, who then shared the information with households within their neighborhood groups. This strategy allowed ONHW to reach a larger target audience than resources would typically allow.

## Figure D-1. Oregon Natural Hazards Workgroup's Leveraged Communication Strategy




Source: Oregon Natural Hazards Workgroup. Partners for Disaster Resistance 5 Year Strategic Plan. 2002.

A total of 14 people attended the focus groups. Ten of the people who attended the focus groups responded to the household survey. The other four respondents were recruited through neighborhood organizations.

The 90-minute focus group session was broken into two sections. The first component, modeled after the focus group technique, included a discussion on the first three main issues of the survey - household risk perception, household preparedness, and willingness to reduce risk. In the discussion, participants were asked to respond to a number of questions regarding their natural hazard preparedness.  The second component, modeled after citizen involvement workshops, included an activity that required participants to prioritize both community planning goals and implementation strategies. In the activity, the participants assumed the role of a City Councilor and were asked to prioritize implementation strategies including: education, regulation, acquisition, and incentives. Participants were also asked to rank generic natural hazard planning goals which included: strengthening citizen action, protecting life, protecting property, protecting natural resources, and enhancing emergency services.

Participants were asked to fill out a pre and post-evaluation form to rate the focus group process. For the purposes of this report, the term focus group is used rather than workshop.

## Organization of Focus Group Findings

This appendix is organized into the three sections: the discussion section, the prioritization activity, and the pre and post-evaluation overview.

***<u>Discussion</u>***

***Reason for Attending:*** This section describes the participant's reasons for attending the focus group.

***Natural Hazard Experience:*** This section includes information about participants' experiences with natural hazards including:

- Hazards that respondents have experienced;
- How the participant was impacted by the experience;
- What hazards they felt the City is at risk from; and
- What concerns they have about natural hazards in their community.

***Preparedness/ Risk Reduction Activities:*** This section provides an overview of the steps participants have taken to prepare for or reduce the risk from natural hazards.

***Willingness to Take Action:*** This section outlines participants' willingness to take further preparedness or risk reduction steps at their home. Participants were asked whether or not they would be willing to make their home more resistant to natural hazards, how much they would be willing to spend to do so, and whether or not they would consider the impacts of natural hazards when purchasing or renting a future home.

***Community-wide Risk Reduction:*** This section outlines potential risk reduction actions that the City could undertake and also provides some insight on who participants feel should be responsible for planning for natural hazards in their community.

***<u>Prioritization Activity</u>***

***Implementation Strategy Prioritization:*** This section provides the results of the prioritization activity for the implementation strategies which include: education, regulation, acquisition, and incentives.

***Planning Goal Prioritization:*** This section provides the results of the planning goal prioritization which included: strengthening citizen action, enhancing emergency services, protecting life, protecting natural resources, protecting property.

***<u>Pre and Post-Evaluation Overview</u>***

This section provides information that was gathered through the pre and post-evaluation process.

# Discussion Section

The following section outlines the outcomes of the discussion section of the focus group process.

## Reasons for attending

Participants were asked to share with the group their reasons for attending the focus group. This question helped in understanding what motivated the individual to participate. Participants in all of the focus groups were concerned about terrorism. Several people came to the focus groups to learn how to protect themselves and their families from terrorist threats. Several attendees had received information about natural hazards from the Tualatin Valley Fire and Rescue, which motivated them to learn more. Several participants were interested in making a 72-hour kit, and in learning about new things to add to 72-hour kits. Many respondents had experience with natural disasters, which caused them to want to prepare for them. One participant had recently moved to Beaverton from the Midwest, and wanted to learn more about hazards in Oregon. Another participant was a first time homeowner, and wanted to know what to do in the event of a natural disaster. One individual worked with a Washington County emergency communications group, and wanted to learn what the city was doing in the natural hazards planning process. Particular concerns included urban fire, earthquake, and landlords not being interested in keeping rental units safe.

## Natural Hazard Experience

### Have you been affected by natural hazards?

Participants were asked to indicate whether or not they have been affected by natural hazards in the past. Most of the participants had experienced some sort of natural hazard in their lifetime. Many of the participants had been affected by natural hazards, including the eruption of Mt. St. Helens, earthquakes, and flooding. Several participants witnessed the Columbus Day Storm, while some had witnessed hurricanes on the east coast. One attendee remembered a tornado hitting near Vancouver in the late seventies.

### How you been affected by natural hazards?

Those participants that had been affected were asked about the ways in which they were affected. One participant's home acquired foundation cracks in their home because of subsidence. One person went 21 days without power after a large storm. People remembered that they had to wear masks when St. Helens erupted.

### Which hazards could affect Beaverton in the future?

Participants were asked to indicate which hazards they thought Beaverton was most at risk to. Hazards that participants mentioned included: windstorms, earthquakes, landslides, wildfire, and flooding.

This question also brought up several discussions about how people prepare for natural hazards. For example, some felt that it is difficult to get people to prepare for something that think will never happen. Many people think Oregon does not have earthquakes. People also said that the media often puts out misinformation, and people have a hard time knowing what to do with it. It was also brought up that earthquake insurance is very expensive. Participants felt that the average person could not buy earthquake insurance.

### Are you concerned about hazards?

Asking whether or not participants were concerned about natural hazards in their community followed the question above. Participants were asked to describe their concerns. All participants indicated that they were concerned about natural hazards. Their concerns included: earthquakes, windstorms, flooding in creeks, effectiveness of communication, the ability of the population to be mobile, young people with children, and ability to contact family members.

## Preparedness / Risk Reduction Activities

### Have you taken steps to prepare for disasters/reduce risk?

Individuals were asked what steps, if any, they had taken to reduce the risk posed by natural hazards in their community. Most participants had taken at least minimal steps to prepare for disasters and reduce risk. The level of preparedness varied considerably, from very prepared to not prepared. Many had a 72 -hour kit and fire extinguishers. Some participants had strapped their water heater and stored necessary tools to turn off water and gas in the case of an emergency. A few had a back-up power sources, and some had stored water. A few participants had a family plan, though many were concerned about the fact that they did not have a family plan in place. Some had met with neighbors to establish a disaster plan. One participant had braced the second story of their home, and one had secured the foundation of their house.

### Why have you taken steps?

To understand the motivations behind taking risk reduction steps, participants were asked why they had implemented the risk reduction strategies listed above. The major reasons that people had for taking steps to prepare were because of articles in newspapers, concerns about terrorism, and experience with natural disasters, particularly Mt. St. Helens. One participant had worked for the Fire Department most of his life, which exposed him to many emergency situations. One person commented, “a disaster would encourage us to prepare more!”

### Have you formed a family emergency plan?

In order to gain an understanding of how prepared participants were, they were asked whether or not they had a family emergency plan. Most participants had not finished their family emergency plan.

### Is there anything you can do to be more prepared?

To gain an understanding of how knowledgeable participants were about risk reduction steps, they were asked what else they could do to reduce risk. Most participants felt that there was more they could do to prepare. One subject that people considered to be very important was organizing among neighbors. People talked about the Fire Department getting overwhelmed in a disaster, and how people must be able to look out for themselves in these situations. One participant mentioned neighborhood groups that responded to the Loma Prieta earthquake disaster in San Francisco as a good example of effective neighborhood organization. Many participants felt that they needed to establish an out of state contact in the case of an emergency. Many also said they simply needed to spend more time to prepare. Finally, participants discussed the role church organizations and other community groups getting involved in educating people.

## Willingness to Take Action

### Would you be willing to make your home more disaster resistant?

Participants were asked if they would be willing to make their home more resistant to disasters. Most participants would be willing to do basic preparedness activities before they would be willing to make structural changes. Most everyone agreed that there are serious cost concerns when it comes to structural mitigation. People would want to know how much damage a natural disaster would cause and what the probability of a disaster happening before doing structural improvements. One participant prepared his house for Y2K by installing a generator, which was very costly. Individuals indicated that it takes a lot of time and money. Participants agreed that there should be a neighborhood plan – people in the neighborhood need to know who has the generators, who has the provisions, etc. Many people also do not want to have to think too much about emergency preparedness. As one participant said, “I need someone to spoon feed me.”

### How much money would you be willing to spend to do so?

Following the question about making homes more disaster resistant, participants were asked to indicate how much they would be willing to spend to make their home more disaster resistant. Participants had difficulty with this question because they did not know how much certain mitigation measures would cost. As a result, few participants responded to this question. One participant said it depends on income- $100 dollars per month was offered as a suggestion. Another asked, “At what point do you stop spending money?” The participant was willing to do a 72-hour kit but was hesitant about doing structural retrofits. One participant would do whatever he could do himself. For most participants there was a trade off between time and money. Either they had the time but not the money or they had the money but not the time to complete any of the activities.

### If you were buying a home, would you be wiling to pay more for a disaster resistant home?

Participants were asked if they would be willing to pay more for a home that had disaster resistant features. Many participants were willing to spend more, but only to a certain point. Some people felt they do not have the means to pay more.

## Community-wide Risk Reduction

### What steps should Beaverton take in mitigating natural hazards?

In an effort to gain public input of steps that the City could take to reduce risk in the future, participants were asked to provide mitigation activities the City could implement. Participants felt that education through flyers and brochures was an important activity. People suggested establishing a voluntary program whereby emergency/hazard experts come to people's homes to inspect for risk. People felt that a better inventory of resources and more knowledge about potential impacts is important. Also, one person felt that Washington County is overall very prepared for disasters. Participants also suggested that the City work with community organizations in order to improve coordination and education.

### Who has the primary responsibility in reducing risk?

Participants were asked to indicate who in the community has the primary responsibility to reducing the risks posed by natural hazards. Participants felt that individual citizens had primary responsibility along with the community. One participant said that they used to think the federal government was responsible, but not anymore. People were concerned that because sense of community is lacking, it is hard to organize on a local level. This may get in the way of communities pulling together to prepare for disaster. Another participant suggested that the City's role was in educating the public and coordinating activities and programs.

# Prioritization Activity

The prioritization activity was developed in order to prioritize plan goals and implementation strategies.

## Implementation Strategy Prioritization

*"The purpose of the next activity is to determine your preferred method of achieving natural hazard planning goals. Your community is in the process of developing a plan to reduce the community's risks from natural hazards. The planning team has identified a number of plan goals that will help reduce the community's risk from natural hazards. They are: protecting life, protecting property, protecting natural resources, enhancing emergency services, and strengthening citizen action.*

*Congratulations! You have just been elected to the City Council. At tonight's council/board meeting, you and your fellow Councilors/Commissioners have been asked to decide how the* *community can meet the plan goals that were previously identified. There are 4 methods for achieving the goals: education, regulation, acquisition, and incentives. For each of the plan goals, you will be given a stack of money. Your job is to spend the money on the method of achieving the goals that you prefer. You should place the money in the envelope(s) that matches the method(s) that you prefer. For instance, you may place all your money on one method or distribute the money among the methods in any combination that matches your preferences for each of the goals. It is important to note that all 4 methods may not be applicable to all 5 goals. Each goal is presented on an individual poster and includes a definition of the goal as well as some examples for each of the methods. I will now give you a brief demonstration."*

*"This board is for the goal of strengthening citizen action. The color of the board and the color of the money match, so on the purple board, I would use my purple money. Here is the definition of the goal. Here are the examples for each of the methods. If I only supported using incentives as a means to strengthen citizen action, I would put all the money in the incentives envelope. If I support both but prefer one over the other, I would distribute my dollars in both envelopes with more money in the one that I preferred over the other."*

*"At this time, please double check your envelopes, you should have a stack of red, orange, green, blue, and purple money. Also note that each color set has a different number of bills. You will have 12 minutes to make your decision and place your money on the boards for all 5 goals. Feel free to ask questions at any time if you have them."*

*"Time is up, we are now going to move onto the next portion of the activity. We would now like you to prioritize the goals that you just worked with. I will now share with you the scenario."*

Table D-1 illustrates the dollars that were spent on each of the implementation strategies for each of the five generic plan goals. For each of the plan goals, education was the most popular implementation strategy.

### Table D-1. Focus Group Scenario # 1 Results

| Goal | Implementation Strategies | | | |
|---|---|---|---|---|
| | Education | Incentives | Acquistion | Regulation |
| Strengthening Citizen Action | $7,000 | $5,666 | N/A | N/A |
| Enhancing Emergency Services | $4,500 | $3,250 | N/A | $4,250 |
| Protecting Natural Resources | $4,000 | $2,800 | $3,400 | $2,800 |
| Protecting Property | $5,000 | $2,800 | $800 | $4,400 |
| Protecting Life | $5,750 | $3,500 | N/A | $3,750 |

Source: ONHW/CPW. Citizen Focus Groups. 2003

## Planning Goal Prioritization

*"After several months of developing the plan to reduce the community's risk to natural disasters, the plan has been approved by the City Council and is ready to be put into practice. However, changes in the state and local economy have lead to budget cuts and now the budget can only support 3 of the plan goals. In tonight's Council/Board meeting you have been asked to decide which three plan goals are the most important to you. If the cost of implementing each of the goals is equal, which are the most important? You will be using this ballot to vote for the 3 goals that you think are most important. Place a 1 next to the goal with the highest priority, a 2 next to the goal with second highest priority and a 3 next to the goal with the third highest priority. You will have 5 minutes to cast your vote and return it to the ballot box right here. Feel free to browse the posters again to make your decision.*

*Time is up, we have about 20 minutes left in our session tonight. We would like to close with a brief presentation on some activities you can take at your home to prepare for and reduce risks posed by natural hazards. We would also like to follow up with a post evaluation."*

Table D-2 represents the number of votes each goal received during the voting portion of the activity. People were given a sheet, and asked to place a number 1, 2, or 3 next to the goals that they considered most important when dealing with natural hazards. Participants were asked to only rank their top three choices. This table presents the total number of votes, and their rank, for each goal as completed by all three of the focus groups. Protecting life, enhancing emergency services, and strengthening citizen action were received the most votes overall.

**Table D-2. Focus Group Scenario #2 Results**

| Goal | Total Votes | Highest Priority | 2nd Highest Priority | 3rd Highest Priority |
|---|---|---|---|---|
| Strengthening Citizen Action | 7 | 2 | 2 | 3 |
| Enhancing Emergency Services | 10 | 2 | 5 | 3 |
| Protecting Natural Resources | 5 | 0 | 1 | 4 |
| Protecting Property | 5 | 1 | 2 | 2 |
| Protecting Life | 11 | 7 | 3 | 1 |

Source: Oregon Natural Hazards Workgroup. Citizen Focus Group. 2003.

# Pre and Post-evaluation Overview

The focus groups were not only a way to inform the City of citizens needs and perceptions when it comes to natural hazards, but it was also a way for citizens to learn from one another. In an effort to gauge any changes in participant knowledge, a pre-evaluation was distributed before the session and a post-evaluation was distributed after the session. In the pre-evaluation, participants were asked to respond to statements regarding the importance of citizen involvement in planning for natural hazards as well as whether or not they were aware of steps that could take to reduce their risks. Participants were also asked whether they have taken any steps at their home and if not, why. Respondents were also asked to identify what type of information regarding natural hazards they would like to receive in the future. The post-evaluation was identical to the pre-evaluation, except that it also asked a few questions regarding the process in an effort to understand how the participants liked or disliked the process. Responses to these questions can be used to better the process in future mitigation planning processes. A total of thirteen individuals participated in the pre and post-evaluations.

On the pre-evaluation, participants were asked whether they received the household preparedness survey, eight had, three had not and two were not sure. This question was included in order to assess which recruitment strategy brought the individual to the focus group. If they did not receive the survey, it is assumed that they were recruited through the NACs.

In general, most participants either strongly agreed or agreed with each of the statements provided in either the pre or post-evaluation form. No respondent selected strongly disagree for any of the statements. The post-evaluation was used to see if there had been any change in participant's feelings about the general citizen involvement statements. To find a change, the total number of pre-evaluation responses for each option (i.e. "strongly agree" or "neutral") were calculated and compared to the total number of post-evaluation responses for the same statements. A positive value indicates that the total number of responses in the post-evaluation was higher than the total number of responses to that statement in the pre-evaluation. A negative value indicates that the total number of responses in the post-evaluation was lower than the total number of responses to that statement in the pre-evaluation. For example, in Table D-3, the first statement about informing citizens about risk indicates a positive two for the "strongly agree" and a negative two for the "agree". What this means is that two individuals changed their responses from "agree" to "strongly agree" between the pre and post-evaluations. Table D-3 illustrates the change in responses from the pre-evaluation to the post-evaluation for each of the statements.

### Table D-3. Focus Group Pre/Post-Evaluation Change

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| It is important for citizens to be informed about their risks | 2 | -2 | -- | -- | -- |
| It is important for citizens to be involved in planning for natural hazards | -1 | 1 | 1 | -1 | -- |
| It is important for citizens to assist in developing community priorities* | -2 | 1 | -- | -- | -- |
| It is important for citizens to actively reduce their risks | -2 | -- | 2 | -- | -- |
| It is important to plan for hazards at my home | 3 | -3 | -- | -- | -- |
| It is important to plan for hazards in my community | 1 | -1 | -- | -- | -- |
| I would be more supportive of a plan that I helped to develop | 1 | -- | -1 | -- | -- |

Source: Oregon Natural Hazards Workgroup. Citizen Focus Group. 2003.

* The change does not balance out for this statement because one respondent did not respond to this statement in the post-evaluation.

On the individual level, three participants have one positive change in their responses; one participant had two positive changes; and three participants had three positive changes. On the other hand, three participants had one negative change; two participants had two negative changes; and one participant had three negative changes. Nine out of thirteen participants changed their responses to at least one of the statements during the course of the evening.

During both the pre and post-evaluations, participants were asked whether or not they were aware of steps they could take to make their home safer from natural hazards. In the pre-evaluation, three individuals indicated that they were not aware of any steps, while ten individuals indicated that they were aware. In the post-evaluation, the number of individuals still unaware of mitigation steps had reduced to one. A follow-up question to this first one asked whether they had taken any steps at their home. Eight individuals indicated that they had not taken any steps to make their home more resistant to natural hazards while five individuals had. When asked why they had not taken any steps, common responses included not having enough time, it was not a priority, they had not thought to do anything and they lacked the information they needed in order to be persuaded to take action. This “why not” question is important in the mitigation planning process because it provides insights on what might motivate people to take action. For instance, if residents understood their risk and also understood that they could take steps to reduce the risk, more homes in the community could become more disaster resistant. No one mentioned that money was the factor stopping him or her from taking action.

A final general preparedness question asked what type of information or resources would they be interested in receiving in the future. The number one response was information about steps that households can take to reduce risk, followed by information about steps that the City is taking to reduce risks community wide.

The post-evaluations also included questions regarding the actual focus group process. Participants were asked to rank the components and quality of the focus groups session. This information is helpful in providing recommendations on how to better the process in the future. The following table displays the number of responses for each of the ranking of the various focus group components.

### Table D.4. Focus Group Component Evaluation Results

| Component | Just Right | Neutral | Needs Improvement |
|---|---|---|---|
| Length | 13 | 0 | 0 |
| Discussion | 11 | 1 | 0 |
| Facilitators | 11 | 2 | 0 |
| Location | 10 | 3 | 0 |
| Time | 9 | 3 | 1 |
| Introduction | 9 | 3 | 0 |
| Activity | 8 | 4 | 1 |
| Education/Resources | 7 | 4 | 1 |

Source: Oregon Natural Hazards Workgroup. Citizen Focus Group. 2003.

As Table D.4 illustrates, the length of the session was the highest ranked feature, followed by both the discussion section and the facilitators. The low "just right" ranking of the education/resource section is understandable because time constraints prohibited the full presentation of the planned education materials during the focus group on both evenings. This was compensated for by presenting each of the participants with a packet of information on household preparedness steps, preparedness resources and web links, as well as information on mitigation planning concepts. Another interesting result from this question was the lower ranking of the activity session of the focus group. This is particularly interesting because the activity component can provide important information to the planning steering committee on citizen preferences for both goals and implementation strategies. This result might be explained by the lack of a clear link between what the participants were doing in the activity and the statement above about how the steering committee could use the information. Had this connection been effectively communicated to the participants, the response to this question might have been different.

Participants were also given an opportunity to share what they saw as the strengths and weaknesses of both the discussion and activity section. The following tables list all the comments provided by participants.

### Table D.5. Focus Group Discussion Section Open-ended Results

| Discussion Section | |
|---|---|
| **Strengths** | **Weaknesses** |
| Very well presented | Not going deep enough into responses |
| Lots of talent | More follow-up questions |
| Good communication skills | Would have liked more citizen participation |
| Good thought provoking questions | Seems more questions should be asked, maybe yes/no questions |
| Group size was conducive to participation | What next? |
| Good cookies | |
| Small group allowed everyone to be involved | |
| Kept a good discussion going | |
| Good follow-up to responses | |
| Open discussion for everyone to share their thoughts and experiences | |
| Discussion are better | |
| Good – nice to hear other's experience and preparation for disasters | |
| Enjoyed frankness of discussion | |
| Asked important questions | |

Source: Oregon Natural Hazards Workgroup. Citizen Focus Group. 2003.

**Table 4.6. Focus Group Activity Section Open-ended Comments**

| Activity Section | |
|---|---|
| **Strengths** | **Weaknesses** |
| Makes one think about those things | Not enough direct discussion regarding specific preparedness for individual homes and communities |
| Well organized | Results were not made clear |
| Effective communication tool | Need to receive the responses |
| Unique activity | Less scripted |
| Good – it sure make you think about issues, the cost and what will motivate people to take action | More questions posed to the group so they are sure they understand |
| A lot of points to think about | Took a while to figure out what to do |
| Like the activity – made me think | Forget the monopoly money exercise |
| Good thought provoking goals | Seems remote |
| | Take more time to go through the example |

Source: Oregon Natural Hazards Workgroup. Citizen Focus Group. 2003.

For the most part, the comments tended to be fairly positive. Many open-ended comments about the activity section concur with the findings of the previous question that the activity section was not overwhelmingly effective from the participant's perspective. Based on the evaluation of the activity section, it seems that the activity might be better suited for stakeholder groups or the steering committee rather than citizens.

# Appendix E
# Economic Analysis of Natural Hazard Mitigation Projects

This appendix outlines three approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan,* (Oregon State Police – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigatio*n. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

## Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce "ripple-effects" throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

## What are Some Economic Analysis Approaches for Evaluating Mitigation Strategies?

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods are outlined below:

### Benefit/cost Analysis

Benefit/cost analysis is a key mechanism used by the state Office of Emergency Management (OEM), the Federal Emergency Management Agency (FEMA), and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project worth pursuing will have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs).

### Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

#### Investing in public sector mitigation activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

#### Investing in private sector mitigation activities

Private sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

## STAPLE/E Approach

Conducting detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of these methods is the STAPLE/E Approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a systematic fashion. This criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's April How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E Approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process".

**Social**: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?

- Will the action cause social disruption?

**Technical**: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

**Administrative**: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

**Political**: Consult the mayor, city council or county planning commission, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

**Legal**: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

**Economic**: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?

- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)?
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

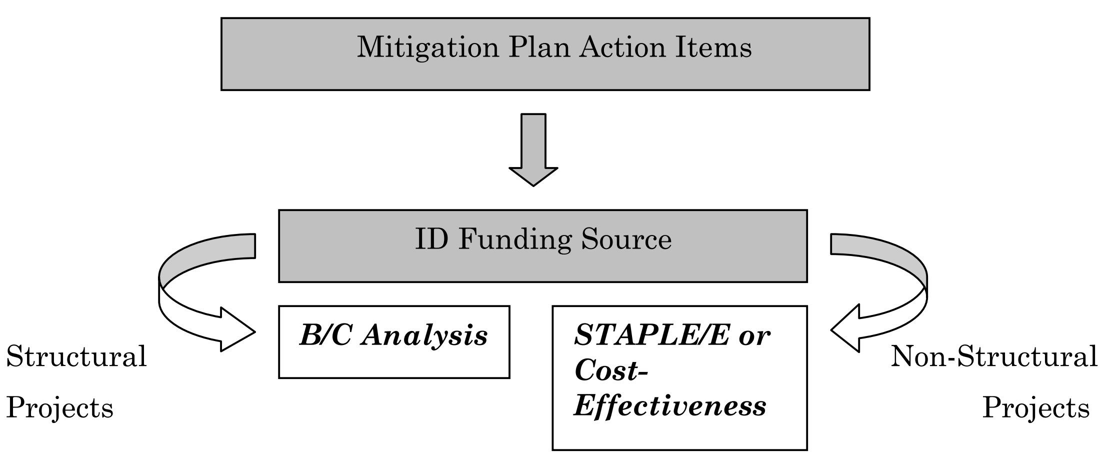
**Environmental**: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed Benefit/Cost Analyses.

## When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.



## Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

### 1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation project can assist in minimizing risk to natural hazards, but do so at varying economic costs.

### 2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- ***Determine the project cost.*** This may include initial project development costs, and repair and operating costs of maintaining projects over time.
- ***Estimate the benefits.*** Projecting the benefits or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.
- ***Consider costs and benefits to society and the environment.*** These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

- ***Determine the correct discount rate.*** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

### 3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- ***Net present value***. Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.
- ***Internal Rate of Return***. Using the *internal rate of return* method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

## Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or landowner as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

### Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

## Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. Many communities are looking towards developing multi-objective projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

# Resources


CUREe Kajima Project, *Methodologies For Evaluating The Socio-Economic Consequences Of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997.

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics Inc., 1996.

Federal Emergency Management Agency *Report on Costs and Benefits of Natural Hazard Mitigation.* Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in The City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects* Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olson Associates, Prepared for Oregon State Police, Office of Emergency Management, July 1999.

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Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency Management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

# Appendix F
# List of Acronyms

## City

| | |
|---|---|
| CCI | Committee for Citizen Involvement |
| CD | Community Development Department |
| CERT | Community Emergency Response Team |
| C of C | Chamber of Commerce |
| DPT | Disaster Planning Team |
| ED | Economic Development Department |
| EM | Emergency Management Program |
| EN | Engineering Department |
| EOC | Emergency Operations Center |
| EOP | Emergency Operations Plan |
| ISD/GIS | Information Systems Department – Geographic Information Systems |
| MO | Mayor's Office |
| NAC | Neighborhood Association Committee |
| NP | Neighborhood Program |
| OP | Operations Department |
| UF | Urban Forestry Program |
| WM | Waste Management |

## County and Regional

| | |
|---|---|
| CPAWC | Cooperative Public Agencies of Washington County |
| CREW | Cascadia Region Earthquake Workgroup |
| CWS | Clean Water Services (formerly Unified Sewerage Agency) |
| IISOI | Insurance and Information Services of Oregon & Idaho |
| JWC | Joint Water Commission |
| Metro | Metropolitan Regional Government |
| OCEM | Office of Consolidated Emergency Management |
| PGE | Portland General Electric |
| PLP | Partners for Loss Prevention |
| NN | Northwest Natural |
| REMG | Regional Emergency Management Group |
| REMTEC | Regional Emergency Management Technical Committee |
| SWCD | Soil and Water Conservation District |
| TPAC | Tualatin Public Awareness Committee |
| TR | Tualatin Riverkeepers |
| TRWC | Tualatin River Watershed Council |
| TVFR | Tualatin Valley Fire and Rescue |

| | |
|---|---|
| TVHPRD | Tualatin Valley Hills Parks and Recreation Department |
| TVID | Tualatin Valley Irrigation District |
| TVWD | Tualatin Valley Water District |
| WC | Washington County |
| WCCEM | Washington County Consolidated Office of Emergency Management |
| WCFDB | Washington County Fire Defense Board |
| WCLUT | Washington County Department of Land Use and Transportation |
| WEA | Westside Economic Alliance |

## Oregon

| | |
|---|---|
| AGC | Associated General Contractors |
| AOC | Association of Oregon Counties |
| BCD | Building Codes Division (Department of Consumer and Business Services) |
| BPA | Bonneville Power Administration |
| CPW | Community Planning Workshop (University of Oregon) |
| DAS | Department of Administrative Services |
| DCBS | Department of Consumer and Business Services |
| DEQ | Department of Environmental Quality |
| DHS | Department of Human Services |
| DLCD | Department of Land Conservation and Development |
| DOGAMI | Department of Geology and Mineral Industries |
| DSL | Division of State Lands |
| ESD | Education Service District |
| GIHMT | Governor's Interagency Hazard Mitigation Team |
| GNRO | Governor's Natural Resources Office (State of Oregon) |
| LCDC | Land Conservation and Development Commission (State of Oregon) |
| LOC | League of Oregon Cities |
| OCS | Oregon Climate Service |
| ODA | Oregon Department of Agriculture |
| ODF | Oregon Department of Forestry |
| ODFW | Oregon Department of Fish and Wildlife |
| ODOT | Oregon Department of Transportation |
| OEM | Office of Emergency Management (Oregon State Police) |
| OEMA | Oregon Emergency Management Association |
| OERS | Oregon Emergency Response System |
| OHIRA | Oregon Hazard Identification and Risk Assessment |
| ONHW | Oregon Natural Hazards Workshop (University of Oregon) |
| ORS | Oregon Revised Statutes |
| ORVOAD | Oregon Voluntary Organizations Active in Disaster |
| OSFM | Office of State Fire Marshal (Oregon State Police) |
| OSP | Oregon State Police |
| OSSPAC | Oregon Seismic Safety Policy Advisory Commission |
| OSU | Oregon State University |
| OUS | Oregon University System |
| OWEB | Oregon Watershed Enhancement Board |

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| PSU | Portland State University |
| PUC | Public Utility Commission |
| WRD | Water Resources Department |

## Federal

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| AASHTO | American Association of State Highway and Transportation Officials |
| AIA | American Institute of Architects |
| APA | American Planning Association |
| ARC | American Red Cross |
| ASCE | American Society of Civil Engineers |
| ATC | Applied Technology Council |
| b/ca | benefit/cost analysis |
| BFE | Base Flood Elevation |
| BLM | Bureau of Land Management |
| BSSC | Building Seismic Safety Council |
| CDBG | Community Development Block Grant |
| CFR | Code of Federal Regulations |
| CRS | Community Rating System |
| CVO | Cascade Volcano Observatory (USGS) |
| EDA | Economic Development Administration |
| EPA | Environmental Protection Agency |
| ER | Emergency Relief |
| EWP | Emergency Watershed Protection (NRCS Program) |
| FAA | Federal Aviation Administration |
| FAS | Federal Aid System |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| FMA | Flood Mitigation Assistance (FEMA Program) |
| FTE | Full Time Equivalent |
| GIS | Geographic Information System |
| GNS | Institute of Geological and Nuclear Sciences (International) |
| GSA | General Services Administration |
| HAZUS | Hazards U.S. |
| HBA | Home Builders Association |
| HMGP | Hazard Mitigation Grant Program |
| HMST | Hazard Mitigation Survey Team |
| HUD | Housing and Urban Development (United States, Department of) |
| IBHS | Institute for Business and Home Safety |
| ICC | Increased Cost of Compliance |
| IHMT | Interagency Hazard Mitigation Team |
| NCDC | National Climate Data Center |
| NFIP | National Flood Insurance Program |
| NFPA | National Fire Protection Association |
| NHMP | Natural Hazard Mitigation Plan (also known as “409 Plan”) |
| NIBS | National Institute of Building Sciences |

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| NIFC | National Interagency Fire Center |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NPS | National Park Service |
| NRCS | Natural Resources Conservation Service |
| NWS | National Weather Service |
| SBA | Small Business Administration |
| SEAO | Structural Engineers Association of Oregon |
| SHMO | State Hazard Mitigation Officer |
| TDR | Transfer of Development Rights |
| UGB | Urban Growth Boundary |
| URM | Unreinforced Masonry |
| USACE | United States Army Corps of Engineers |
| USBR | United States Bureau of Reclamation |
| USDA | United States Department of Agriculture |
| USFA | United States Fire Administration |
| USFS | United States Forest Service |
| USGS | United States Geological Survey |
| USGS-CVO | United States Geological Survey – Cascades Volcano Observatory |
| WSSPC | Western States Seismic Policy Council |